N00174.AR.000635
NSWC INDIAN HEAD
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FEASIBILITY STUDY REPORT FOR GROUNDWATER AT SITE 36 NSWC INDIAN HEAD MD
3/1/2007
TETRA TECH NUS

Feasibility Study Report

Site 36 – Closed Landfill

Naval Support Facility Indian Head
Indian Head, Maryland

Naval Facilities Engineering Command
Washington

Contract Number N62470-08-D-1001
Contract Task Order JU03

March 2010

030910/P

FEASIBILITY STUDY REPORT
SITE 36 – CLOSED LANDFILL

NAVAL SUPPORT FACILITY INDIAN HEAD
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Washington
1314 Harwood Street, SE
Washington Navy Yard, D.C. 20374-5018

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CONTRACT NUMBER N62470-08-D-1001
CONTRACT TASK ORDER JU03

MARCH 2010

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ARAR	Applicable or relevant and appropriate requirement
AVS	Acid volatile sulfide
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of concern
COMAR	Code of Maryland Regulations
CSM	Conceptual Site Model
CTO	Contract Task Order
EPA	United States Environmental Protection Agency
FS	Feasibility Study
GIS	Geographic Information System
GRA	General response action
HASP	Health and safety plan
HI	Hazard index
IAS	Initial Assessment Study
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
ILCR	Incremental lifetime cancer risk
LUC	Land use control
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MEC	Munitions and explosives of concern
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NSF-IH	Naval Support Facility Indian Head
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear aromatic hydrocarbon
PPE	Personal protective equipment
PRG	Preliminary remediation goal
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act

RfD	Reference Dose
RI	Remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SEM	Simultaneously extracted metals
SSP	Site Screening Process
SVOC	Semivolatile organic compound
TAL	Target Analyte List
TBC	To be considered
TCL	Target Compound List
Tetra Tech	Tetra Tech NUS, Inc.
TOC	Total organic carbon
USC	United States Code
UXO	Unexploded ordnance
VOC	Volatile organic compound

EXECUTIVE SUMMARY

This Feasibility Study (FS) Report for Naval Support Facility Indian Head (NSF-IH), Indian Head, Maryland, was prepared by Tetra Tech NUS, Inc. (Tetra Tech) in response to Contract Task Order (CTO) JU03 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-08-D-1001. NSF-IH is a Naval Support Activity, South Potomac facility within the Naval District Washington Region. The purpose of this FS Report is to develop and evaluate potential remedial alternatives for mitigating environmental contamination at Site 36 (Closed Landfill). Environmental studies of this site began in 2002. A Site Screening Process (SSP) Report prepared in May 2008 (Tetra Tech, 2008) presented the environmental data collected from the site and evaluated the data to estimate the human health and environmental risks resulting from on-site contamination.

Site 36 covers approximately 3 acres in the western portion of the Stump Neck Annex along Roach Road adjacent to Chickamuxen Creek. The landfill was used from 1972 to 1974 and has been inactive since that time. The filled area was a wetland or marsh adjacent to the creek, and the fill was believed to contain metal casings from mines, bombs, and torpedoes. The contents were reportedly certified inert and did not contain any explosives or chemicals when buried. A geophysical survey identified anomalies (i.e., potential buried items) throughout the site area. Soil borings encountered waste (wood fragments mixed with soil) from 4 to 8 feet below ground surface (bgs) and 8 to 12 feet bgs. The waste layer was overlain by soil fill (gravel, sand, silt, and clay). The borings also encountered river mud and peat below the waste layer. The peat and river mud most likely correspond to former creek sediments present before the area was filled. Surface debris, including tires, empty 55-gallon drums, a large cube-shaped tank, an airplane part, and a large item that appeared to be farm machinery, is present along the Chickamuxen Creek shoreline. The surface of the site is mostly covered with grasses and brushy vegetation, which becomes very dense near the shoreline adjacent to the site. Some small and large trees are present.

Shallow groundwater beneath the landfill was encountered at a depth of approximately 4 feet bgs. Much of the landfill material is below the water table. Shallow groundwater beneath the site is not considered to be a naturally formed aquifer. Under its natural setting before being filled, this water would have existed as surface water associated with Chickamuxen Creek or a wetland. Shallow groundwater beneath the landfill is not within the area of attainment, as defined by the United States Environmental Protection Agency (EPA). The area of attainment defines the area over which groundwater cleanup levels must be met. It encompasses the area outside the waste boundary and up to the boundary of the contaminant plume. Groundwater beneath the waste management boundary is not within the area of attainment. Shallow groundwater flows toward Chickamuxen Creek, and the creek is not being adversely affected by the discharge of shallow groundwater. There is no shallow groundwater beyond the site boundary because the site is adjacent to the creek.

This FS develops remedial alternatives that address risks from exposure to landfill waste. There are no unacceptable risks to human health and the environment from exposure to surface soil, surface water, sediment, or sediment pore water. There are inherent risks and safety concerns from exposure to landfill waste. Risks to human health are also associated with exposure to metals (i.e., arsenic, iron, and manganese) in shallow groundwater used as a source of drinking water under a hypothetical future residential exposure scenario.

Alternative 1, the no-action alternative, is included to serve as a baseline against which other alternatives are compared. However, five-year reviews are required as waste and contaminants would be left in place at concentrations exceeding those suitable for unlimited use and unrestricted exposure.

Alternative 2 would include debris removal, land use controls (LUCs), monitoring, and 5-year reviews. LUCs would include land and groundwater use restrictions to prevent unauthorized excavation, residential development, and use of shallow groundwater. Monitoring would be conducted to confirm that contaminants are not migrating from the site at unacceptable levels. Five-year reviews are required because waste and contaminants would be left in place at concentrations exceeding those suitable for unlimited use and unrestricted exposure. Alternative 2 would not conform to state landfill closure design requirements and would require the Maryland Department of the Environment to issue a variance to COMAR 26.04.07.21.

Alternative 3 would include debris removal, a soil cover, LUCs, monitoring, and 5-year reviews. Existing vegetation would be removed, a 2-foot-thick soil cover would be placed over the landfill, and the site would be revegetated. This alternative would include the same LUCs, monitoring, and 5-year reviews described for Alternative 2. Alternative 3 would not conform to state landfill closure design requirements and would require the Maryland Department of the Environment to issue a variance to COMAR 26.04.07.21.

Alternative 4 would include debris removal, an engineered cap, LUCs, monitoring, and 5-year reviews. Existing vegetation would be removed, an impermeable multi-layer cap would be installed, and the capped area would be revegetated. Existing vegetation would not be replaced because the site would need to be revegetated with plants that would not penetrate the cap. This alternative would include the same LUCs, monitoring, and 5-year reviews described for Alternative 2. Alternative 4 would conform to state landfill closure design requirements.

Alternative 5 includes removal of the entire landfill. The excavated material would be dewatered, as necessary, screened for potential ordnance items, and transported off site for disposal. The excavated area would not be backfilled but would be allowed to revert to open water in Chickamuxen Creek or converted to a wetland. LUCs, monitoring, and 5-year reviews would not be required.

Table ES-1 summarizes the evaluation of remedial alternatives and presents the costs for each alternative considered. The remedial alternatives were developed and evaluated in accordance with the nine criteria required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

TABLE ES-1

SUMMARY OF ANALYSIS OF ALTERNATIVES
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

Evaluation Criterion	Alternative 1 – No Action	Alternative 2 – Land Use Controls	Alternative 3 – Soil Cover and Land Use Controls	Alternative 4 – Engineered Cap and Land Use Controls	Alternative 5 – Landfill Removal
Threshold Criteria					
Overall Protection of Human Health and the Environment	No reduction in potential risks.	LUCs would reduce risks to human health and the environment.	Soil cover and LUCs would reduce risks to human health and the environment.	Engineered cap and LUCs would reduce risks to human health and the environment.	Landfill removal would reduce risks to human health and the environment.
Compliance with ARARs					
Chemical-specific	Not applicable.	No ARARs.	No ARARs.	No ARARs.	No ARARs.
Location-specific	Not applicable.	No ARARs.	Could be designed to attain ARARs that apply.	Could be designed to attain ARARs that apply.	Could be designed to attain ARARs that apply.
Action-specific	Not applicable.	Could be designed to attain ARARs that apply. Would require a variance from state landfill closure requirements.	Could be designed to attain ARARs that apply. Would require a variance from state landfill closure requirements.	Could be designed to attain ARARs that apply.	Could be designed to attain ARARs that apply.
Primary Balancing Criteria					
Long-Term Effectiveness and Permanence	Would allow uncontrolled risks to remain.	LUCs would reduce risks to human health. Monitoring and use restrictions would provide adequate and reliable controls.	Soil cover and LUCs would reduce risks to human health. Monitoring and use restrictions would provide adequate and reliable controls.	Engineered cap and LUCs would reduce risks to human health. Monitoring and use restrictions would provide adequate and reliable controls.	Landfill removal would eliminate risks to human health. Monitoring and use restrictions would not be required.
Reduction of Toxicity, Mobility, or Volume through Treatment	No treatment.	No treatment.	No treatment.	No treatment.	No treatment.
Short-Term Effectiveness	Not applicable. No short-term impacts or concerns.	No impacts to community, workers, or environment. One month to implement.	No impacts to community. Exposure of workers to contaminated media could be adequately controlled. Existing habitat would be destroyed until soil cover is revegetated. Two months to implement.	No impacts to community. Exposure of workers to contaminated media could be adequately controlled. Existing habitat would be destroyed until cap is revegetated; could not be planted with existing types of vegetation that could damage impermeable layer. Four months to implement.	Hauling wastes off site would generate additional traffic. Exposure of workers to contaminated media could be adequately controlled. Existing terrestrial habitat would be destroyed and would revert to open water or converted to wetland. Sixteen months to implement.
Implementability	Nothing to implement.	LUCs could be strictly enforced because site is located at military facility.	Alternative consists of common remediation methods that are readily available and implementable. LUCs could be strictly enforced because site is located at military facility.	Alternative consists of common remediation methods that are readily available and implementable. LUCs could be strictly enforced because site is located at military facility.	Alternative consists of common remediation methods that are readily available but would be difficult to implement. There are implementability concerns associated with excavation of waste below the water table and screening excavated materials for MEC.
Cost					
Capital	$0	$91,000	$1,094,000	$2,887,000	$18,952,000
O&M	$20,000 every 5 years	$18,000 per year plus $20,000 every 5 years	$18,000 per year plus $20,000 every 5 years	$18,000 per year plus $20,000 every 5 years	$0
Present Worth	$42,700	$358,000	$1,361,000	$3,154,000	$18,952,000
Modifying Criteria					
State Acceptance	Not applicable.	To be determined.	To be determined.	To be determined.	To be determined
Community Acceptance	Not applicable.	To be determined.	To be determined.	To be determined.	To be determined.

ARARs Applicable or relevant and appropriate requirements.
LUCs Land use controls.
MEC Munitions and explosives of concern.
O&M Operation and maintenance.

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

This Feasibility Study (FS) Report has been prepared for Naval Facilities Engineering Command (NAVFAC) Washington by Tetra Tech NUS, Inc. (Tetra Tech) in response to Contract Task Order (CTO) JU03 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-08-D-1001. The purpose of this FS was to develop and evaluate potential remedial alternatives to mitigate environmental contamination at Site 36 – Closed Landfill at the Naval Support Facility Indian Head (NSF-IH) in Indian Head, Maryland. NSF-IH is part of Naval Support Activity, South Potomac within the Naval District Washington Region. The FS Report summarizes information presented in the Site Screening Process (SSP) Report (Tetra Tech, 2008) and discusses the basis for remedial action that may be required at Site 36. In this report, remedial technologies and process options are evaluated and screened to select those that are most viable for the site conditions and contaminants. The technologies and process options that pass the screening are combined to form remedial alternatives to address site contamination. The remedial alternatives are also evaluated to distinguish positive and negative aspects of each alternative.

Section 1.0 summarizes background information, physical characteristics of the site, previous investigations, and the results of the human health and ecological risk screening evaluations from the SSP Report and provides the Conceptual Site Model (CSM). Section 2.0 presents the objectives and goals of remediation, including preliminary remediation goals (PRGs), chemicals of concern (COCs), and media of concern. Section 3.0 presents the identification and screening of technologies and process options. Section 4.0 presents the development and screening of alternatives. Section 5.0 presents the detailed analysis of alternatives. Section 6.0 presents the comparative analysis of alternatives.

1.2 FACILITY BACKGROUND

NSF-IH is located in northwestern Charles County, Maryland. As shown on Figure 1-1, NSF-IH is approximately 25 miles southwest of Washington, D.C. NSF-IH is a military facility consisting of the Main Area on the Cornwallis Neck Peninsula and the Annex on Stump Neck. As shown on Figure 1-2, the Main Area is bounded by the Potomac River on the northwest, west, and south, Mattawoman Creek to the south and east, and the Town of Indian Head to the northeast. Stump Neck Annex is located across Mattawoman Creek and is not contiguous with the Main Area. The location of Site 36 is shown on Figure 1-2.

The primary mission of the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), the main tenant at NSF-IH, is as follows:

- To provide services in energetics for all warfare centers through engineering, fleet and operation support, manufacturing technology, limited production, and industrial base support.

- To provide research, development, testing, and evaluation of energetic materials, ordnance devices and components, and other related ordnance engineering standards including chemicals, propellants and their propulsion systems, explosives, pyrotechnics, warheads, and simulators.

- To provide support to all warfare centers, military departments, and the ordnance industry for special weapons, explosives, safety, and ordnance environmental issues.

- To execute other responsibilities as assigned by the Commander of the IHDIV-NSWC.

1.3 SITE 36 BACKGROUND

1.3.1 Site Location and Description

Site 36 – Closed Landfill is located in the western portion of Stump Neck Annex along Roach Road adjacent to Chickamuxen Creek (Figures 1-2 and 1-3). The landfill was used from 1972 to 1974 and has been inactive since that time. The filled area was most likely part of Chickamuxen Creek and/or a wetland or marsh adjacent to the creek, and the fill was believed to contain metals casings from mines, bombs, and torpedoes. The contents were reportedly certified inert and did not contain any explosives or chemicals when buried. Wood fragments were also buried in the landfill. Subsequent anecdotal information from personnel who formerly worked in Building 2010, which is located northeast of the landfill, indicated that disassembled metal parts were disposed in the creek across (west of) Roach Road from Building 2010.

1.3.2 Topography and Surface Features

As illustrated on Figure 1-3, the site is relatively flat and slopes gradually to the west from Roach Road to Chickamuxen Creek. The landfill covers an area of approximately 3 acres. The surface of the site is mostly covered with grasses and brushy vegetation, which becomes very dense near the shoreline. Some small and large trees are present.

Chickamuxen Creek is adjacent to the northern, western, and southern boundaries of the site. Precipitation either infiltrates into the soil or runs off into the creek. There are no obvious drainage channels at the site. Metal debris, such as abandoned storage tanks, equipment, and machinery, is present along portions of the shoreline adjacent to the site.

1.3.3 Site Geology/Soils

Logs from soil borings for the two monitoring wells (S36MW001 and S36MW002) installed in the landfill indicate that shallow geologic materials consist of fill (e.g., wood fragments) mixed with sand, silt, clay, and gravel to depths of 8 to 12 feet below ground surface (bgs). Sand, silt, clay, and gravel were encountered at depth ranges of 0 to 4 ft bgs and 0 to 8 feet bgs, respectively. Wood fragments mixed with the same materials were encountered in the two soil borings at depth ranges of 4 to 8 feet bgs and 8 to 12 feet bgs. The natural material beneath the fill consists of peat and river mud underlain by sand. The peat and river mud most likely correspond to former creek and/or wetland sediments present before the area was filled.

1.3.4 Site Hydrogeology

Shallow groundwater beneath the site is unconfined and was encountered at a depth of approximately 4 feet bgs. Groundwater would be expected to flow toward Chickamuxen Creek.

1.4 PREVIOUS INVESTIGATIONS

1.4.1 Initial Assessment Study

The site was identified as a landfill in the Initial Assessment Study (IAS) (Hart, 1983). A site visit during the IAS indicated the presence of metal parts on the surface of the site. The IAS did not contain a recommendation concerning future actions.

1.4.2 Site Screening Investigation

A geophysical survey was conducted during a site screening investigation in 2002 (Tetra Tech, 2003). The survey identified anomalies throughout the area of the suspected landfill identified in the IAS indicating that waste may have been disposed at the site. Surface debris scattered along the shoreline was present. Because of the size of the site and the potential for contamination, additional investigation was recommended.

1.4.3 Site Visit

A site visit was conducted in April 2003 in preparation for an SSP investigation. Materials observed along the shoreline included tires, empty 55-gallon drums, a large cube-shaped tank, a part from an airplane, and a large item that appeared to be a part of a piece of farm machinery.

1.4.4 Site Screening Process

1.4.4.1 Site Screening Process Investigation

The 2005 SSP investigation was conducted to identify the presence or absence of contamination at Site 36. The field investigation included installation of three monitoring wells (one upgradient and two within the landfill) and collection of six surface soil, three shallow groundwater (unfiltered), six surface water (unfiltered), six sediment, and four sediment pore water (unfiltered and filtered) samples. Surface soil samples were collected from the surface of the landfill. Surface water, sediment, and sediment pore water samples were collected from Chickamuxen Creek. Sample locations are shown on Figure 1-4. All samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), explosives, nitrocellulose, nitroglycerin, nitroguanidine, Target Analyte List (TAL) metals, and hexavalent chromium.

Several VOCs, many SVOCs [mostly polynuclear aromatic hydrocarbons (PAHs)], one explosive, and many metals were detected in surface soil. Three VOCs, four SVOCs, three explosives, and several metals were detected in groundwater. No VOCs, SVOCs, or explosives were detected in the upgradient monitoring well. One VOC, several metals, and cyanide were detected in surface water. Three VOCs, many PAHs, one explosive, several metals, and cyanide were detected in sediment. One VOC, two SVOCs, four explosives, and several metals were detected in sediment pore water. The specific chemicals detected in each medium are summarized in Table 1-1.

Based on the results, it was determined that additional information on potential ecological risks, particularly to benthic organisms in Chickamuxen Creek, was needed. The field investigation is fully described in the SSP Report (Tetra Tech, 2008.)

1.4.4.2 Benthic Macroinvertebrate Study

In 2007, a benthic macroinvertebrate study was conducted to evaluate potential ecological risks to benthic organisms in Chickamuxen Creek. Sediment samples were collected from nine locations and submitted for macroinvertebrate analysis. Sample locations are shown on Figure 1-4. Samples were also analyzed for PAHs, TAL metals, cyanide, acid volatile sulfide (AVS)/simultaneously extracted metals

(SEM) (cadmium, copper, lead, nickel, silver, and zinc), total organic carbon (TOC), and grain size. The field investigation is fully described in the SSP Report (Tetra Tech, 2008).

1.4.4.3 Human Health Risk Screening Evaluation

The following section provides a summary of the risk screening evaluation conducted as part of the SSP. Additional details are provided in the SSP Report (Tetra Tech, 2008). Based on current and anticipated future land use and the location of the site, military personnel, civilian employees, contractors, and trespassers were considered the most likely human receptors. However, to evaluate the site on a conservative basis, risks were only evaluated based on a hypothetical future residential exposure scenario. The risk screening evaluation included a comparison of maximum detected concentrations in soil, groundwater, surface water, sediment, and sediment pore water to United States Environmental Protection Agency (EPA) risk-based screening levels, and estimation of incremental lifetime cancer risks (ILCRs) for carcinogens and hazard indices (HIs) for non-carcinogens. The ILCRs and HIs were estimated based on a ratio of the maximum concentration to the risk screening criteria.

The estimated total ILCR for the future resident is 7.6E-04, which is greater than the EPA acceptable risk range of 1E-04 to 1E-06. The ILCR for each medium is as follows:

- There are no unacceptable carcinogenic risks from exposure to surface soil or surface water.

- The estimated ILCR for exposure to shallow groundwater is 5.2E-04. The primary risk driver is arsenic.

- The estimated ILCR for exposure to sediment pore water is 1.1E-04, which is slightly greater than the EPA acceptable risk range. The primary risk driver is arsenic. The evaluation conservatively assumed that sediment pore water would be used as a source of drinking water. However, this assumption is very conservative, and the risk estimate is considered to be biased high. Although sediment pore water could be considered as shallow groundwater that is discharging into Chickamuxen Creek, it is highly unlikely that a water supply well would be installed in the creek.

- The estimated ILCR for exposure to sediment is 1.1E-04, which is slightly greater than the EPA acceptable risk range. The primary risk drivers are benzo(a)pyrene, benzo(b)fluoranthene, and arsenic. The evaluation conservatively assumed that exposure to sediment would be the same as exposure to surface soil under a residential land use scenario (350 days/year). However, this assumption is very conservative, and the risk estimate is considered to be biased high because exposure to sediment under a realistic residential exposure scenario would be much less frequent. If exposure to sediment was half the assumed exposure to soil, the ILCR would be within the acceptable risk range. Also, the risk screening levels for soil are based on the ingestion and inhalation routes of exposure, which is a reasonable assumption; however, exposure to sediment under a more realistic assumption would primarily be associated with dermal contact. There are no screening levels for dermal exposure.

The estimated total cumulative HI is 21, which is greater than the EPA threshold of 1.0. Even when target organs were considered, the cumulative HI for several target organs is greater than 1.0. There are no unacceptable non-carcinogenic risks for exposure to surface soil and surface water. Target organ HIs are greater than 1.0 for shallow groundwater, sediment pore water, and sediment. Risk drivers for shallow groundwater are arsenic (HI = 2.0), iron (HI = 2.6), and manganese (HI = 2.1). Risk drivers for pore water are iron (HI = 3.2) and manganese (HI = 3.7), and the only risk driver for sediment is iron (HI = 1.7). The non-carcinogenic risk estimates for exposure to sediment pore water and sediment are considered to be biased high for the reasons stated above.

The human health risk screening evaluation also concluded that migration of chemicals detected in soil to shallow groundwater is not considered to be problematic.

In summary, the only potential risk to human health associated with exposure to chemicals is from exposure to shallow groundwater under a residential exposure scenario. COCs include arsenic, iron, and manganese. There is also an inherent risk from exposure to buried landfill waste.

1.4.4.4 Ecological Risk Screening Evaluation

This section provides a summary of the ecological risk screening evaluation. Additional details are provided in the SSP Report (Tetra Tech, 2008). The screening evaluation included comparison of detected chemical concentrations to EPA ecological screening levels and alternative guidelines, food-chain modeling, and a benthic macroinvertebrate evaluation.

There are no unacceptable risks to ecological receptors. Potential risks to plant and invertebrates from chemicals detected in surface soil are acceptable. Based on comparisons to ecological screening levels, there are potential risks to aquatic organisms from exposure to surface water and potential risks to sediment invertebrates from exposure to sediment and sediment pore water. However, results from the benthic macroinvertebrate surveys indicate that the benthic community is not being adversely affected. Also, metals detected in sediment should not be bioavailable based on AVS/SEM results. Results from food-chain modeling indicate that potential risks to terrestrial wildlife are acceptable.

1.5 CONCEPTUAL SITE MODEL

Wastes disposed in the landfill are the likely sources of contamination. Contaminants present in the waste could have contaminated adjacent soil or water as the former swamp/marsh area was filled. Surface soil contaminants could migrate to Chickamuxen Creek surface water and sediment via surface runoff. Surface soil contaminants could also migrate vertically to shallow groundwater. Groundwater contaminants could migrate to surface water, sediment, and sediment pore water in Chickamuxen Creek, which is the likely groundwater discharge point. Chemicals detected in each medium are summarized in Table 1-1.

In general, VOCs and explosives detected in surface soil were not detected in other environmental media. PAHs detected in surface soil were not detected in groundwater, surface water, or sediment pore water but were detected in sediment. This indicates that PAHs may be migrating, or have migrated, from soil to Chickamuxen Creek. Metals detected in surface soil were detected in all other environmental media. This indicates that metals may be migrating, or have migrated, from soil to groundwater and Chickamuxen Creek.

In general, the VOCs, SVOCs, and explosives detected in shallow groundwater within the landfill were not detected in Chickamuxen Creek or the upgradient monitoring well. However, many of the metals detected in shallow groundwater were detected in the creek. This indicates that metals may be migrating, or have migrated, from groundwater to Chickamuxen Creek.

Based on the human health and ecological risk screening evaluations conducted as part of the SSP, the only potential unacceptable risks are from exposure to metals (arsenic, iron, and manganese) in shallow groundwater used as a source of drinking water under a residential exposure scenario. The detected concentrations are shown in Table 1-2. There is no shallow groundwater beyond the landfill boundary, which is the Chickamuxen Creek shoreline. Although PAHs and metals may have migrated from the site to Chickamuxen Creek, the detected concentrations do not pose unacceptable risks to human health, ecological receptors, or the environment.

TABLE 1-1

CHEMICALS DETECTED BY MEDIUM
SITE 36 - CLOSED LANDFILL
NSF-IH, MARYLAND
PAGE 1 OF 2

Chemical	Surface Soil		Groundwater		Surface Water		Sediment		Sediment Pore Water	
	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection
Volatile Organic Compounds	**µg/kg**		**µg/L**		**µg/L**		**µg/kg**		**µg/L**	
2-Butanone							28	4/6		
Acetone	170	6/6					47	6/6		
Chloromethane					0.89	3/6				
Ethylbenzene			0.99	1/3						
Isopropylbenzene	20	1/6								
Methyl acetate	11	1/6								
Styrene	2	1/6								
Tetrachloroethene	12	6/6								
Toluene			55	2/3					4	4/4
Trichloroethene			0.6	1/3						
Trichlorofluoromethane							3	1/6		
Semivolatile Organic Compounds	**µg/kg**		**µg/L**		**µg/L**		**µg/kg**		**µg/L**	
2-Methlynapthalene	200	1/6								
4-Methylpenol			93	2/3					1	1/4
Acenaphthylene	56	1/6					290	1/15		
Acetophenone			2	1/3					2	1/4
Anthracene	89	1/6					420	1/15		
Benzaldehyde	98	4/6	2	2/3			320	3/6		
Banzo(a)anthracene	250	2/6					1,200	6/15		
Benzo(a)pyrene	240	4/6					1,000	7/15		
Benzo(b)fluoranthene	470	5/6					2,300	7/15		
Benzo(g,h,i)perylene	110	4/6					490	4/15		
Benzo(k)fluoranthene	190	2/6					790	6/15		
Carbazole							61	1/6		
Chrysene	330	4/6					1,300	6/15		
Di-n-butyl phthalate	49	3/6								
Fluoranthene	370	5/6					1,300	8/15		
Indeno(1,2,3-cd)pyrene	120	2/6					480	4/15		
Naphthalene	82	1/6								
Phenanthrene	110	2/6					120	5/15		
Phenol			8	2/3						
Pyrene	370	5/6					1,200	9/15		

TABLE 1-1

CHEMICALS DETECTED BY MEDIUM
SITE 36 - CLOSED LANDFILL
NSF-IH, MARYLAND

Chemical	Surface Soil		Groundwater		Surface Water		Sediment		Sediment Pore Water	
	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection
Explosives	**mg/kg**		**µg/L**		**µg/L**		**mg/kg**		**µg/L**	
1,3,5-Trinitrobenzene									0.076	1/4
1,3-Dinitrobenzene									0.65	1/4
2,4,6-Trinitrotoluene									0.077	1/4
2,6-Dinitrotolueme			1.4	2/3						
4-Nitrotoluene									0.073	1/4
Nitrocellulose	3.7	6/6								
Nitroglycerin							0.55	1/6		
RDX			0.69	2/3						
Tetryl			0.31	1/3						
Metals	**mg/kg**		**µg/L**		**µg/L**		**mg/kg**		**µg/L**	
Aluminum	6,290	6/6	839	1/3	948	6/6	30,700	15/15	1,930	4/4
Antimony			2.1	1/3			4.5	6/15		
Arsenic	6.2	6/6	22.4	2/3			17.7	15/15	4.9	4/4
Barium	48.3	6/6	1,570	2/3	35.6	6/6	255	15/15	280	4/4
Beryllium	0.44	6/6					1.7	15/15		
Cadmium	3.1	3/6	1.1	3/3	0.71	1/6	16	15/15	1.3	4/4
Calcium	1,060	6/6	121,000	3/3	20,900	6/6	5,990	15/15	34,500	4/4
Chromium	12.2	6/6			1.5	3/6	110	15/15	19.7	4/4
Copper	46.6	6/6			7.5	1/6	127	13/15	33.1	4/4
Iron	16,000	6/6	67,700	3/3	3,620	6/6	93,500	15/15	82,800	4/4
Lead	178	6/6	8.1	3/3	13.6	3/6	4,100	15/15	14	4/4
Magnesium	856	6/6	32,600	3/3	8,570	6/6	3,870	15/15	27,100	4/4
Manganese	298	6/6	1,560	3/3	492	6/6	2,080	15/15	2,690	4/4
Mercury	0.097	6/6					2.9	11/15		
Nickel	10.4	6/6	6.9	1/3	2	6/6	102	14/15	364	4/4
Potassium	432	6/6	16,600	3/3			3,500	15/15	7,130	1/4
Silver							4.9	8/15		
Sodium	66.8	3/6	98,500	3/3	26,300	6/6	755	10/15	166,000	4/4
Vanadium	19.6	6/6			2.3	4/6	66.5	15/15	3.8	3/4
Zinc	81	6/6					840	15/15	70.4	42.5
Miscellaneous Parameters	**mg/kg**		**µg/L**		**µg/L**		**mg/kg**		**µg/L**	
Cyanide					5.1	1/6	0.26	2/15		

Blank cell indicates chemical was not detected.
mg/kg - Milligrams per kilogram
µg/kg - Micrograms per kilogram
µg/L - Micrograms per liter

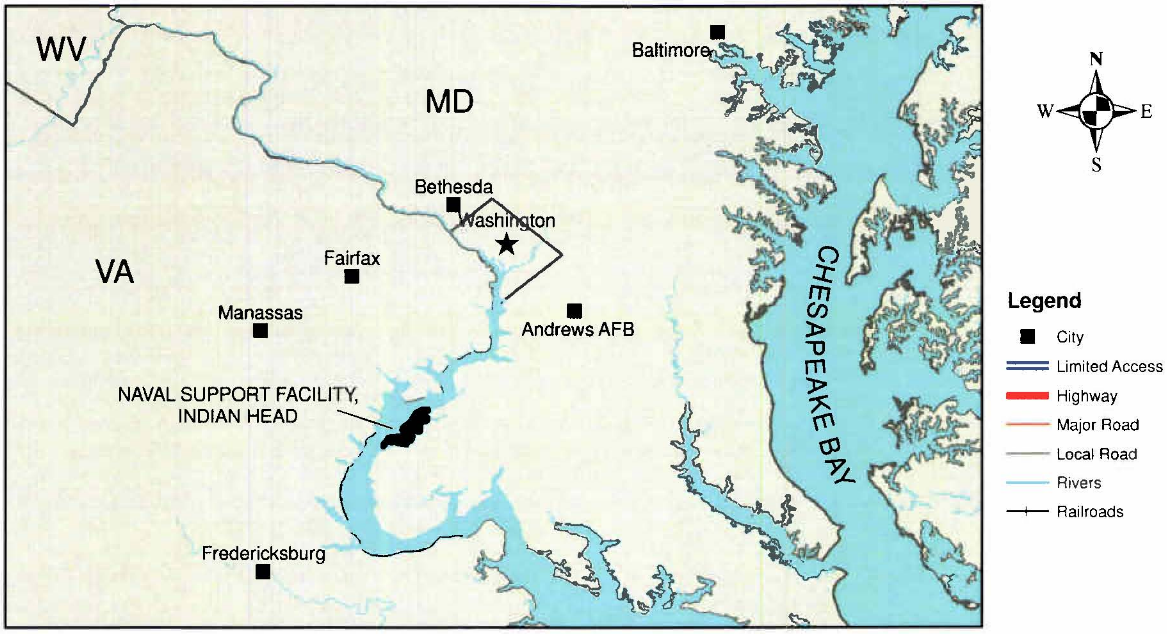
TABLE 1-2

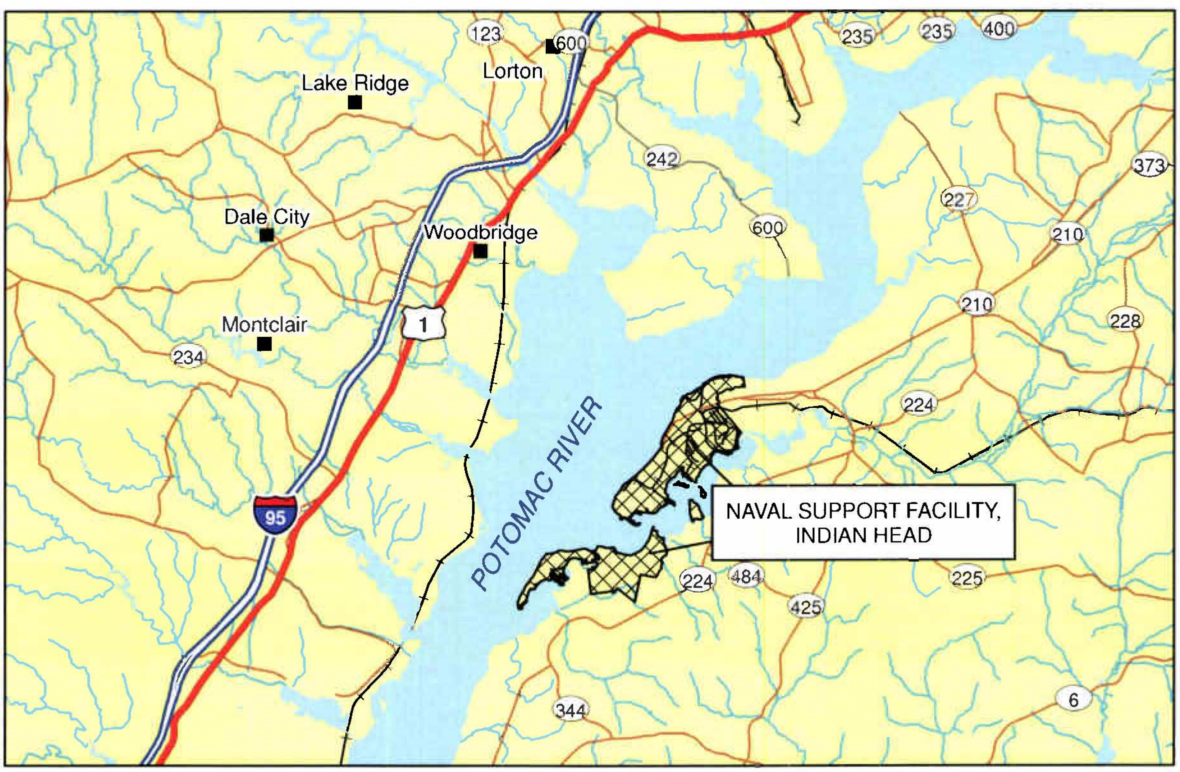
CHEMICALS OF CONCERN FOR GROUNDWATER
SITE 36 - CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

Analyte	S36MW001	S36MW001-D	S36MW002	S36MW003 (upgradient)
Metals (µg/L)				
Arsenic	4.4	7.2	22.4	2 U
Iron	67,400	67,700	64,700	101
Manganese	805	776	1,560	132

µg/L - Micrograms per liter.
D - Duplicate sample.
U - Not detected.

P:\GIS\NSWC_INDIAN_HEAD_NEW\FACILITY_LOCATION.MXD 3/20/09 KM





DRAWN BY K. MOORE	DATE 3/20/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO JU03
CHECKED BY K. TURNBULL	DATE 3/20/09	FACILITY LOCATION MAP NAVAL SUPPORT FACILITY, INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY KCT — DATE 3/20/09
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 1-1 — REV 0

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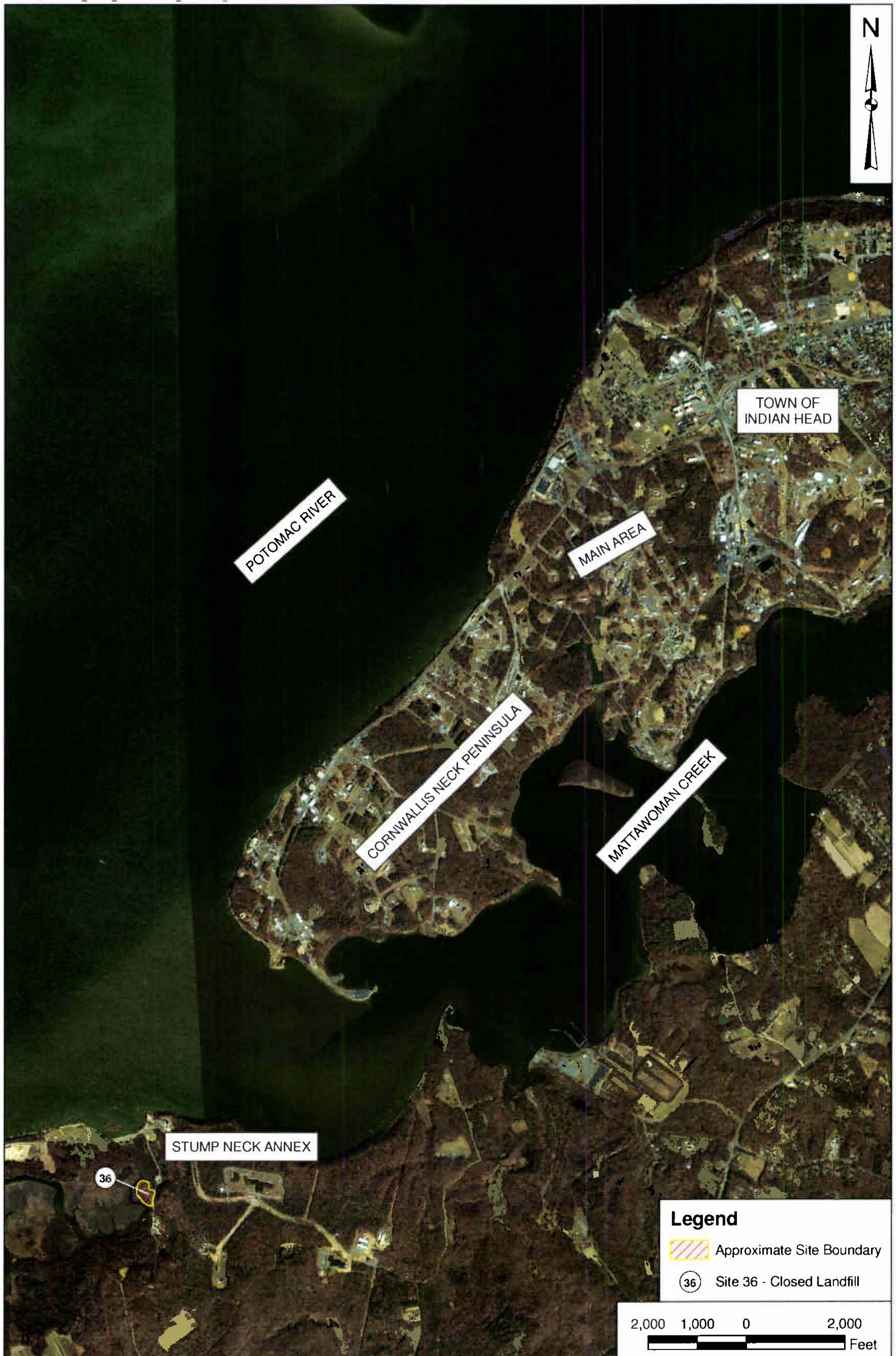
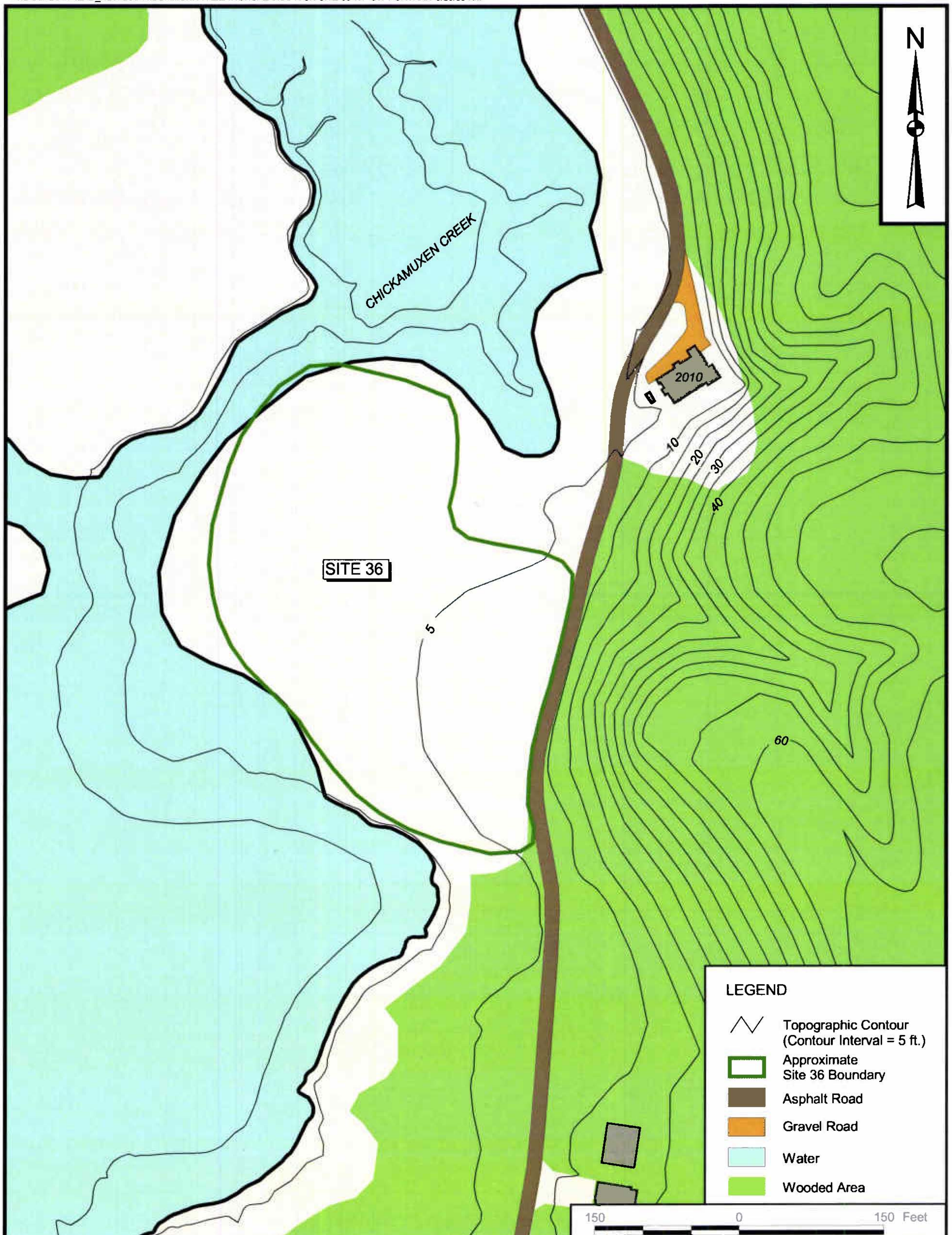


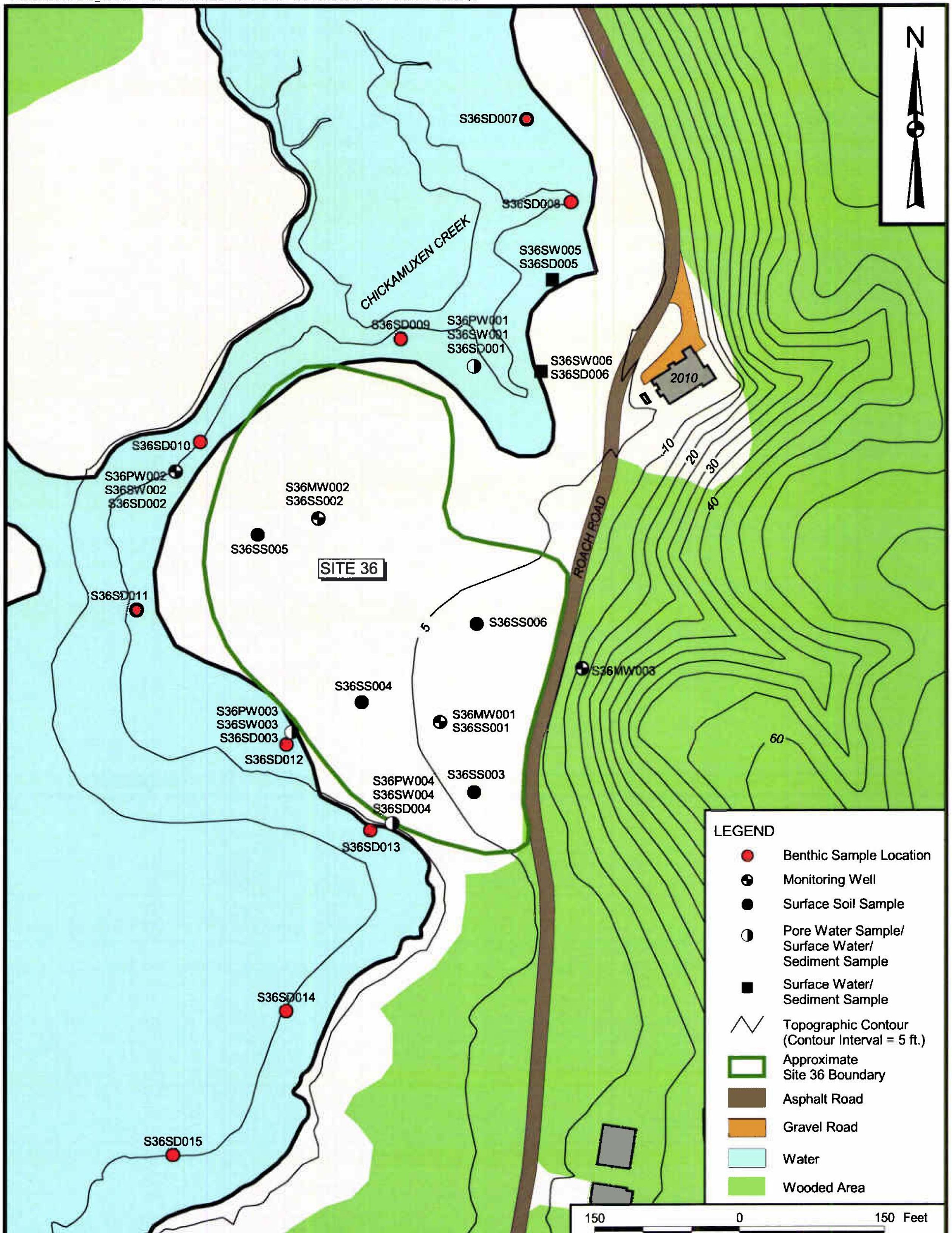
DRAWN BY K. MOORE	DATE 12/13/07	Tetra Tech NUS, Inc.	CONTRACT NUMBER G02050	OWNER NUMBER JU03
CHECKED BY K. TURNBULL	DATE 3/20/09	SITE LOCATION MAP SITE 36 NAVAL SUPPORT FACILITY, INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY KCT	DATE 3/20/09
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 1-2	REV 0

P:\GIS\INDIANHEAD_NSWC\APR\COMMUNITYRELATIONSPLAN.APR SN SITE 36 WP SW PORTRAIT 3/20/09 KM



DRAWN BY K MOORE	DATE 11/21/06	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO JU03
CHECKED BY K. TURNBULL	DATE 3/20/09	SITE CONDITIONS SITE 36 - CLOSED LANDFILL NAVAL SUPPORT FACILITY, INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY KCT — DATE 3/20/09
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-3 — REV 0

P:\GIS\INDIANHEAD_NSWC\APR\COMMUNITYRELATIONSPLAN.APR SN SITE 36 WP SW PORTRAIT 5/20/09 SS



DRAWN BY K MOORE	DATE 11/21/06	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO JU03
CHECKED BY K. TURNBULL	DATE 5/20/09	SAMPLE LOCATIONS SITE 36 - CLOSED LANDFILL NAVAL SUPPORT FACILITY, INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY KCT — DATE 3/20/09
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-4 — REV 0

2.0 REMEDIAL ACTION OBJECTIVES

2.1 INTRODUCTION

This section presents the objectives for remedial action and the factors used to develop remedial actions for Site 36. These factors are the PRGs (clean-up goals) and regulatory requirements and guidance [applicable or relevant and appropriate requirements (ARARs)] that may potentially govern remedial actions. In addition, this section presents the COCs and the conceptual pathways through which these chemicals may adversely affect human health and the environment.

2.2 MEDIUM OF INTEREST

In the SSP Report (Tetra Tech, 2008), the data available for Site 36 were evaluated, and human health and ecological risk screening evaluations were conducted. Based on the recommendations from the SSP Report, an evaluation of ARARs, and anticipated future uses of the site, the only medium of interest is landfill waste. The only unacceptable risks to human health were from exposure to shallow groundwater under a hypothetical future residential exposure scenario. There were no unacceptable risks to ecological receptors. Although chemical concentrations in shallow groundwater were greater than risk-based screening levels, shallow groundwater beneath the site is not a current or potential source of drinking water under the anticipated non-residential use scenario.

Shallow groundwater beneath the landfill is not within the area of attainment, as defined by EPA, and adjacent surface water is not being adversely affected by the discharge of shallow groundwater. The area of attainment defines the area over which groundwater cleanup levels must be met. It encompasses the area outside the waste boundary and up to the boundary of the contaminant plume. Groundwater beneath the waste management boundary is not within the area of attainment. There is no shallow groundwater beyond the waste management boundary because the site is adjacent to the creek. The shallow water-bearing unit beneath Site 36 would not be classified as an aquifer. Site 36 was previously a wetland or part of Chickamuxen Creek that was filled to create the existing topography. Under its natural setting before being filled, the water would have existed as surface water associated with Chickamuxen Creek or the wetland. Therefore, shallow groundwater remediation is not required and is not addressed in this FS report. Groundwater monitoring, however, will be included as part of remedial alternatives for landfill waste, as appropriate.

2.3 REMEDIAL ACTION OBJECTIVES

Based on the potential pathways, receptors of concern, and current and potential future land use scenarios, the remedial action objectives (RAO) for Site 36 are as follows:

- Close the landfill in a manner that protects human health and the environment from direct exposure to contaminated sources at the landfill and from exposure to contaminants migrating from the landfill via surface water runoff and erosion, infiltration to groundwater and groundwater migration, or wind erosion and dust migration in accordance with State of Maryland solid waste management regulations.

- Prevent exposure to contaminants in site groundwater through the application of land use controls prohibiting the use of groundwater as a potable source.

These RAOs were developed following guidance provided in Land Use in the CERCLA Remedy Selection Process (EPA, 1995). According to this guidance, RAOs should reflect the reasonably anticipated future land use or uses. The need for RAOs for groundwater were evaluated following Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (EPA, 1988a). According to this guidance, clean-up levels should be achieved throughout the area of attainment. The area of attainment does not include the area where waste is to be managed or contained on site. Therefore, RAOs were not developed for groundwater.

2.4 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

One of the primary concerns during the development of remedial action alternatives under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is the degree of human health and environmental protection afforded by a given remedy. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that meet or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental regulations. On-site actions need only comply with substantive requirements (e.g., design standards). Off-site actions must comply with substantive and administrative (e.g., permits, recordkeeping) requirements. The term “on site” means the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action.

ARARs consist of the following:

- Any standard, requirement, criterion, or limitation under federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility siting law that is more stringent than the associated federal standard, requirement, citation, or limitation.

Definitions of the two types of ARARs and to be considered (TBC) criteria are as follows:

- Applicable requirements include those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site.

- Relevant and appropriate requirements include those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, although not applicable, address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site that their use is well suited (appropriate) to the particular site.

- TBC criteria are non-promulgated non-enforceable guidelines or criteria that may be useful for developing remedial action alternatives and for determining action levels that are protective of human health and the environment.

Section 121(d)(4) of CERCLA allows the selection of a remedial alternative that will not attain an ARAR if any of six conditions for a waiver of an ARAR exist. These conditions are as follows: the remedial action is an interim measure, and the final remedy will attain the ARAR at completion; compliance will result in greater risk to human health and the environment than other options; compliance is technically impracticable; an alternative remedial action will attain the equivalent of the ARAR; for state requirements, the state has not consistently applied the requirement in similar circumstances; and compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of funds. The last condition only applies to Superfund-financed actions.

ARARs are divided into three categories based on the manner in which they are applied. Some requirements are combinations of the three types of ARARs. The categories are chemical-specific ARARs, location-specific ARARs, and action-specific ARARs and are discussed below.

2.4.1 Chemical-Specific

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Chemical-specific ARARs govern the extent of site cleanup and provide medium-specific guidance on acceptable or permissible concentrations of contaminants. Table 2-1 presents a summary of these chemical-specific ARARs and TBC criteria for Site 36.

2.4.2 Location-Specific

Location-specific ARARs are restrictions based on the concentrations of hazardous substances or the conduct of activities in specific locations. Some examples of specific locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. These ARARs may restrict or preclude certain remedial actions and may apply only to certain portions of the site. Table 2-2 presents a summary of location-specific ARARs and TBC criteria for Site 36.

2.4.3 Action-Specific

Action-specific ARARs are technology- or activity-based controls or restrictions on activities related to management of hazardous substances. Action-specific ARARs pertain to implementing a given remedy. Table 2-3 presents a summary of action-specific ARARs and TBC criteria for Site 36.

2.5 PRELIMINARY REMEDIATION GOALS

No chemical-specific PRGs have been developed for Site 36. The only medium of concern is landfill waste. To the extent that potential remedial alternatives include removal of landfill waste, visual determinations, rather than chemical-specific PRGs, would be used to determine whether removal is complete.

2.6 VOLUME OR AREA OF THE CONTAMINATED MEDIUM

Based on the investigations conducted to date (geophysical survey and soil borings), the landfill covers an area of approximately 150,300 square feet (3.45 acres), and the depth of fill ranges from 0 to 8 feet bgs to 0 to 12 feet bgs. Assuming an average depth of 10 feet, the estimated landfill volume is 55,700 cubic yards.

TABLE 2-1

CHEMICAL-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

Medium	Requirement	Prerequisite	Citation	ARAR Determination	Comments
		Federal			
Groundwater	SDWA standards serve to protect public water systems. Primary drinking water standards consist of federally enforceable MCLs at the tap. An MCL is the maximum level of a contaminant that is allowed in drinking water.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be clean-up standards for on-site groundwater that is a current or potential source of drinking water.	40 CFR 141.2, 141.23, 141.27, 141.28, 141.51, and 141.62	Not applicable	Contaminated groundwater is not within area of attainment.
Groundwater	EPA RfDs are estimates of the amount of a chemical to which humans can be subjected on a daily basis for a lifetime without appreciable risk of adverse health effects.	RfDs can be used to develop remediation goals for chemicals that do not have an MCL, such as iron and manganese.	None	Not applicable	Contaminated groundwater is not within area of attainment.
		State			
Groundwater	Environment Article, Title 9, Subtitle 4 contains standards to protect public water systems. Maryland has adopted the federal MCLs.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be clean-up standards for on-site groundwater that is a current or potential source of drinking water.	COMAR 26.04.01.01, 26.04.01.06, 26.04.01.14, 26.04.01.16, and 26.04.01.17	No applicable	Contaminated groundwater is not within area of attainment.

ARARs Applicable or relevant and appropriate requirements.
CFR Code of Federal Regulations.
COMAR Code of Maryland Regulations.
EPA United States Environmental Protection Agency.
.

MCL Maximum Contaminant Level.
RfDs Reference doses.
SDWA Safe Drinking Water Act.
TBC To be considered.

TABLE 2-2

LOCATION-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Federal					
Endangered Species Act of 1973					
Critical habitat upon which endangered or threatened species depend	Federal agencies are to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat.	Determination of effect on endangered or threatened species or their habitat.	50 CFR 402	Applicable	Bald eagle nesting sites are located at Stump Neck.
Fish and Wildlife Coordination Act, Fish and Wildlife Improvement Act of 1978, and Wildlife Conservation Act of 1980					
Areas affecting streams or other bodies of water	Federal agencies are to consult with appropriate state agency having jurisdiction over wildlife resources before undertaking federal action for the modification of any body of water to conserve those resources.	Diversion, channeling, or other activity that modifies a stream or other water body, including wetlands, and affects fish or wildlife.	16 USC 661; 17 USC 742a; 16 USC 2901	Applicable	Chickamuxen Creek and associated wetlands are in the vicinity of Site 36.
Federal Protection of Wetlands Executive Order 11990					
Wetland	Federal agencies, in carrying out their responsibilities, are to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.	Wetland as defined by Executive Order 11990, Section 7.	40 CFR 6 Appendix A	Applicable	Chickamuxen Creek and associated wetlands are in the vicinity of Site 36.
Federal Floodplain Management Executive Order 11988					
Floodplain	Federal agencies, in carrying out their responsibilities, are to take action to avoid adverse effects, minimize potential harm, and restore and preserve the natural and beneficial uses of floodplains.	Actions that will occur in a floodplain.	40 CFR 6 Appendix A	Applicable	Site 36 lies within the 100-year flood boundary of Chickamuxen Creek.

LOCATION-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
State					
Threatened and Endangered Species					
Critical habitat upon which endangered, threatened, or rare species depend	Requires action to conserve endangered or threatened species and the critical habitats on which they depend. May not reduce the likelihood of either the survival or recovery of a listed species by reducing the reproduction, numbers, or distribution of a listed species or otherwise adversely affect the species.	Determination of effect upon endangered or threatened species or their habitat.	COMAR 08.03.08	Applicable	Bald eagle nesting sites are located at Stump Neck.
Tidal Wetland Regulations					
Tidal wetland	Avoid adverse impacts and minimize losses of tidal wetlands.	Actions that will affect tidal wetland.	COMAR 26.24	Applicable	Chickamuxen Creek is tidal, and associated wetlands are in the vicinity of Site 36.

ARARs Applicable or relevant and appropriate requirement.
CFR Code of Federal Regulations.
COMAR Code of Maryland Regulations.
USC United States Code.

TABLE 2-3

ACTION-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSV-IH, INDIAN HEAD, MARYLAND

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Federal					
Hazardous Waste Management					
On-site waste generation	Waste generator to determine whether waste is hazardous waste.	Generation (e.g., excavation) of solid waste.	40 CFR 262.10(a) and 262.11	Potentially applicable	Material to be transported off site would need to be tested to determine whether it is a hazardous waste.
Generation of hazardous waste	Manifest requirements, pre-transport requirements (i.e., packaging, labeling, placarding), and reporting.	Off-site transport of hazardous waste.	40 CFR 262	Potentially applicable	Applicable only for off-site shipment of hazardous waste.
On-site storage of hazardous waste	Requirements for storage of hazardous remediation waste.	Temporary on-site storage in temporary units (i.e., tanks and containers) and waste piles.	40 CFR 264.553 and 264.554	Potentially applicable	Applicable only for temporary on-site storage of hazardous waste prior to off-site transport.
On-site disposal of hazardous waste	Closure and post-closure care requirements for hazardous waste landfills, including capping, inspection, maintenance, and monitoring.	On-site disposal (e.g., capping) of hazardous waste.	40 CFR 264.111, 264.117, 264.310	Potentially applicable or relevant and appropriate	Applicable for on-site disposal of hazardous waste or relevant and appropriate for on-site disposal of non-hazardous waste.
Off-site disposal of hazardous waste	Waste generator to determine whether hazardous waste is restricted from land disposal.	Off-site disposal of hazardous waste.	40 CFR 268.7 and 268.40	Potentially applicable	Applicable only for off-site disposal of hazardous waste.

TABLE 2-3

ACTION-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSV-IH, INDIAN HEAD, MARYLAND

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Solid Waste Management					
On-site disposal of non-hazardous waste	Closure and post-closure care requirements for municipal waste landfills, including final cover system, inspection, maintenance, and monitoring.	On-site disposal of municipal solid waste.	40 CFR 258.60(a), 258,60(b), 258.61(a), and 258.61(b)	Potentially applicable	Applicable for on-site disposal of non-hazardous waste.
Clean Water Act					
Discharge to surface water	NPDES permit requirements.	Discharge of storm water from construction activity to surface water.	40 CFR 122.26, 122,28, and 122.41	Potentially applicable	Applicable for alternatives that will need to control and manage storm water during construction.
State					
Hazardous Waste Management					
On-site waste generation	Waste generator to determine whether waste is hazardous waste.	Generation (e.g., excavation) of solid waste.	COMAR 26.13.02	Potentially applicable	Material to be transported off site would need to be tested to determine whether it is a hazardous waste.
Generation of hazardous waste	Temporary storage of hazardous waste. Manifest requirements, pre-transport requirements (i.e., packaging, labeling, and placarding), and reporting.	Temporary storage and off-site transport of hazardous waste.	COMAR 26.13.02	Potentially applicable	Applicable only for off-site shipment of hazardous waste.

TABLE 2-3

ACTION-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSV-IH, INDIAN HEAD, MARYLAND

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
On-site disposal of hazardous waste	Closure and post-closure care requirement for hazardous waste landfills, including capping, inspection, maintenance, and monitoring.	On-site disposal (e.g., capping) of hazardous waste.	COMAR 26.13.05.07 and 26.13.05.14	Potentially applicable or relevant and appropriate	Applicable for on-site disposal of hazardous waste or relevant and appropriate for on-site disposal of non-hazardous waste.
Solid Waste Management					
Closure of solid waste landfill	Closure and post-closure care requirements for non-hazardous waste landfills, including capping, inspection, maintenance, and monitoring.	Landfill not closed in accordance with state regulations.	COMAR 26.04.07.21 and 26.04.07.22	Applicable	Applicable for design of soil cover and impermeable capping systems.
Water Management					
Discharge to surface water	NPDES permit requirements.	Discharge of storm waster from construction activity to surface water.	COMAR 26.08.01 through 26.08.04	Potentially applicable	Applicable for alternatives that will need to control and manage storm water during construction.
Land disturbing activities	Requirements for erosion and sediment control.	Land clearing, grading, and other earth disturbance.	COMAR 26.17.01	Potentially applicable	Applicable for alternatives that will disturb earth.
Land development	Requirements for storm water management.	Construction activities.	COMAR 26.17.02	Potentially applicable	Applicable for alternatives where storm water management and control are needed.

TABLE 2-3

ACTION-SPECIFIC ARARs AND TBC CRITERIA
SITE 36 – CLOSED LANDFILL
NSV-IH, INDIAN HEAD, MARYLAND

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Air Quality					
Air emissions	Emission standards for visible emissions and particulate matter.	Soil excavation and handling.	COMAR 26.11.04 and 26.11.06	Potentially applicable	Applicable for alternatives where there may be fugitive emissions from material handling.
Monitoring Wells					
Well construction and abandonment	Requirements for constructing and abandoning wells.	Groundwater monitoring.	COMAR 26.04.04	Potentially applicable	Applicable for alternatives that include construction of new monitoring wells or abandoning existing monitoring wells.
Occupational, Industrial, and Residential Hazards					
Noise generation	Established limits on noise levels not to be exceeded at the property boundary.	Action that will generate noise.	COMAR 26.02.03.02 and 26.02.03.03	Potentially applicable	Applicable for alternatives that will generate noise.

ARARs Applicable or relevant and appropriate requirements.
CFR Code of Federal Regulations.
COMAR Code of Maryland Regulations.
NPDES National Pollutant Discharge Elimination System.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3.1 INTRODUCTION

Identification, screening, and evaluation of potentially applicable technologies and process options are important steps in the FS process. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options that can be combined into remedial alternatives. The basis for technology identification and screening began in Section 2.0 with a series of discussions that included the following:

- Identification of medium of interest
- Development of RAO
- Identification of ARARs
- Identification of volumes and areas of interest

Technology screening is completed and technology evaluation is performed in this section with the following steps:

- Identification of general response actions (GRAs)
- Identification and screening of remedial technologies and process options
- Evaluation of technologies and selection of representative process options

3.2 GENERAL RESPONSE ACTIONS

GRAs describe categories of actions that could be implemented to satisfy or address a component of an RAO for a site. Typically, the formation of remedial alternatives includes combining GRAs to fully address RAOs. When implemented, the combined GRAs are capable of achieving the RAOs that have been developed for each medium of interest at the site. As discussed in Section 2.0, the medium of concern for Site 36 is landfill waste.

The following GRAs were considered for Site 36:

- No action
- Institutional actions
- Containment
- Removal

- Treatment
- Disposal

3.2.1 No Action

The no action response is retained through the FS process as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The no action response provides a comparative baseline against which other alternatives can be evaluated. Under this response, no remedial action is taken. The site is left “as is” without the implementation of any monitoring, land use controls (LUCs), containment, removal, treatment, or other mitigating actions.

3.2.2 Institutional Actions

Institutional actions include various site access controls or land use restrictions to reduce or eliminate direct contact pathways of exposure. These controls could involve the use of monitoring, groundwater and land use restrictions, and access controls. The toxicity, mobility, and volume of the waste or contaminants are not reduced through the implementation of LUCs.

3.2.3 Containment

Another method of reducing risk to human health and the environment is through containment that involves the use of physical measures to reduce the potential for exposure and the potential for contaminant migration. To reduce the migration of contaminants, the contaminated media must be isolated from the primary transport mechanisms such as wind, erosion, surface water, and groundwater. For example, installing surface or subsurface barriers can be used to isolate contaminated media.

3.2.4 Removal

Technologies in this category are used to remove a contaminated medium from its current location to be treated or disposed elsewhere. Removal actions are combined with treatment and/or disposal actions.

3.2.5 Treatment

Technologies in this category include in-situ and ex-situ methods to remove, modify, or bind a contaminant associated with an impacted medium. These methods typically reduce the overall toxicity, mobility, and volume of the impacted medium.

3.2.6 Disposal

Disposal actions include placement of removed and/or treated materials at an on-site or off-site permanent disposal facility. Disposal also includes on-site consolidation of contaminated materials. Disposal actions are combined with removal and/or treatment actions. The toxicity, mobility, or volume of contaminants is not reduced through the singular act of disposal.

3.3 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

In this section, a variety of technologies and process options were identified under each GRA and screened. The screening was first conducted at a preliminary level to focus on relevant technologies and process options based on site conditions and contaminants and the medium of concern. The screening was then conducted on a more detailed level in Section 3.4 based on certain evaluation criteria. Finally, process options were selected to represent technologies that passed the detailed evaluation and screening.

Table 3-1 summarizes the preliminary screening of technologies and process options. It lists the GRA, identifies the technologies and process options, and provides a brief description of the process options, and screening comments. All technologies and process options that were not eliminated are evaluated in greater detail in Section 3.4.

3.4 EVALUATION OF TECHNOLOGIES AND SELECTION OF REPRESENTATIVE PROCESS OPTIONS

3.4.1 Evaluation Criteria

The evaluation criteria for detailed screening of technologies and process options retained after the preliminary screening in Section 3.3 were effectiveness, implementability, and cost. The following are descriptions of the evaluation criteria:

- Effectiveness: Protection of human health and the environment; reduction in toxicity, mobility, or volume; permanence of the solution; ability to address the estimated areas or volumes of contaminated media; ability to meet the remediation goals identified in the RAOs; and technical reliability (innovative versus well proven) with respect to contaminants and site conditions.

- Implementability: Overall technical feasibility at a site; availability of vendors, equipment, storage and disposal services, etc.; administrative feasibility; and special long-term maintenance and operation requirements.

- Cost: Capital cost and operation and maintenance (O&M) costs.

All of the factors listed above may not directly apply to each technology and were only addressed as appropriate. Screening evaluations generally focus on effectiveness and implementability, with less emphasis on cost evaluations. Technologies whose use would be precluded by waste characteristics and inapplicability under site conditions were eliminated from further consideration. At this stage, no technologies were eliminated based solely on cost. A process option within a technology category, however, may not have been carried through if an equally effective process option was available at lower cost.

3.4.2 Evaluation of Technologies and Process Options

The final screening of technologies and process options was based on the evaluation criteria presented in Section 3.4.1. The following table presents the technologies and process options remaining for final screening.

General Response Action	Technology	Process Options
No Action	None	None
Institutional Actions	Monitoring	Groundwater and Surface Water Monitoring
	Access/Use Restrictions	Physical Barriers
	LUCs	Groundwater and Land Use Restrictions
Containment	Capping	Soil Cover or Multimedia Cap
	Erosion Control	Riprap Cover or Vegetation
Removal	Excavation	Excavation
Disposal	Landfill	Hazardous or Non-Hazardous Waste Landfill
		On-Site Consolidation

3.4.2.1 No Action

No action consists of implementing no activities to address contamination. No action was retained as required by the NCP; therefore, no evaluation is conducted.

3.4.2.2 Institutional Actions

Institutional actions retained after the initial screening were groundwater and surface water monitoring, physical barriers, and groundwater and land use restrictions. Monitoring may include collection of groundwater and surface water samples followed by analysis for target contaminants. Access restrictions (e.g., fences, warning signs) can be used to prevent or minimize the potential for human contact with contaminants. Identifying restrictions in the Geographic Information System (GIS) maintained by NSF-IH can be used to prevent future land and groundwater uses that could pose risks to human health.

<u>Effectiveness</u>

Access, land use, and groundwater use restrictions can be effective, depending on the administration of the controls. Monitoring is not effective in controlling risks to human health or the environment, but it can determine the effectiveness of a remedial action or the need for additional remedial action.

<u>Implementability</u>

Access, land use, and groundwater use restrictions and monitoring are readily implementable.

<u>Cost</u>

Costs of access, land use, and groundwater restrictions are low. Costs associated with sampling and analysis are low to moderate depending on the nature of the monitoring program.

<u>Conclusion</u>

Access restrictions (e.g., fence, warning signs) were eliminated because there are no risks to human health from exposure to surface soil.

Land and groundwater use restrictions and monitoring were retained for further consideration.

3.4.2.3 Containment

The technologies considered under containment were capping and erosions controls, as discussed below.

A soil cover consists of a layer of soil placed over the landfill wastes. A soil cover can minimize the potential for direct contact with the waste and can reduce the migration of contaminants caused by surface water infiltration, runoff, and wind erosion.

Multimedia caps (engineered caps) consist of layers of soil, geosynthetic materials, or geocomposite materials placed over the landfill wastes. A cap can minimize the potential for direct contact with waste and can reduce the migration of contaminants caused by surface water infiltration, runoff, and wind erosion. Multimedia caps reduce infiltration to a greater degree than soil covers.

Erosion controls consist of vegetation or riprap placed on the soil cover or cap to minimize contaminant migration from surface runoff or to protect a soil cover or cap from erosion.

Effectiveness

Compacted soil with a topsoil and vegetative cover layer can effectively minimize direct contact with surface contaminants and reduce migration of contaminants by surface water infiltration, runoff, and wind erosion.

A multimedia cap can effectively minimize direct contact with surface contaminants and reduce migration of contaminations by surface water infiltration, runoff, and wind erosion. A multimedia cap would reduce infiltration more effectively than a soil cover.

Erosion controls can be effective for diversion of surface water flow away from the disposal area and for control of runoff from the disposal area.

Implementability

The main concern with implementation of soil covers, multimedia caps, and erosion controls is maintaining integrity from natural and human interferences (e.g., flooding, settlement, unauthorized excavation). Human interferences can be minimized at Site 36 because the site will continue to be part of a federal facility.

Cost

Costs for soil covers are low to moderate, costs for engineered caps are moderate, and costs for erosion controls are low.

Conclusion

Soil covers and engineered caps were retained as an effective means of minimizing exposure, and erosion controls were retained as necessary to protect the soil cover or cap.

3.4.2.4 Removal

Excavation can be performed by a variety of equipment such as front-end loaders, backhoes, clamshells, and draglines. The selection of equipment must consider several factors such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, and site access. The excavation can be backfilled to pre-excavation grades or can be partially backfilled as needed to establish more suitable ecological habitats or building sites. Backfilling is performed using clean fill and includes grading and revegetation.

Effectiveness

Excavation can be effective in the complete removal of contaminated material from a site. Confirmatory sampling is usually required to verify that all contaminated material has been removed. Soil samples can be collected from the sides and bottom of the excavation and analyzed for COCs to ensure that clean-up goals have been attained. It may also be possible to remove landfill waste from uncontaminated soil so that the soil can be returned to the site.

Implementability

Excavation equipment is readily available. The technology is well proven and established in the construction and remediation industries. Excavation below the water table will be required, although it may be possible to lower the water table to below the bottom of the depth of excavation. The removed water may need to be treated and disposed appropriately. As an alternative, “wet” excavation could be performed during which material from below the water is to be dredged and placed on a dewatering pad. The dried material would then be transported off site for disposal (waste and contaminated soil) or used as backfill (uncontaminated soil).

Cost

Excavation costs are typically low, unless unusual conditions (e.g., excavation below water) are encountered.

Conclusion

Excavation is retained for further consideration.

3.4.2.5 Disposal

The technologies considered under disposal were on-site consolidation or off-site disposal in a hazardous or non-hazardous waste landfill.

On-site consolidation of waste would involve excavation of various areas (e.g., near the shoreline) followed by consolidation at one location where waste is already present. Consolidation would be performed to enhance the implementability of a soil cover or multimedia cap, which would be placed over the consolidated waste.

Off-site disposal is applicable to excavated materials. Landfills differ in the types of waste they are permitted to accept. Non-hazardous waste landfills are permitted to accept municipal solid wastes, construction and demolition debris, contaminated soil, and other waste that must be proven to have non-hazardous characteristics. Hazardous waste landfills can accept listed and characteristic hazardous wastes as defined by the Resource Conservation and Recovery Act (RCRA).

Effectiveness

On-site consolidation can be effective for the types of materials present at Site 36. Removal of material along the shoreline with consolidation away from the shoreline would make it easier to install a soil cover or multimedia cap.

Landfilling can be an effective method for waste disposal if the receiving facility is properly designed and operated.

Implementability

Excavation equipment used for consolidation is readily available. The technology is well proven and established in the construction and remediation industries.

There are no implementability concerns associated with off-site disposal. Based on available information, the waste at Site 36 would be non-hazardous.

Cost

Costs associated with on-site consolidation and disposal in a non-hazardous waste landfill would be low to moderate.

Conclusion

On-site consolidation is retained if needed to enhance the constructability of a soil cover or multimedia cap. Off-site disposal is also retained for further consideration.

3.4.3 Selection of Representative Process Options

Table 3-2 summarizes the retained technologies and process options. Representative process options were chosen from each technology to assemble an adequate variety of effective and implementable alternatives and to evaluate the alternatives in sufficient detail to aid in the final selection process. The specific process options selected for the remedial action will be determined during the remedial design or during bid evaluation and selection of the remedial action contractor.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

General Response Action	Technology	Process Option	Description	Screening Comments
No Action	None	Not Applicable	No activities conducted to address contamination.	Required by NCP. Retain for baseline comparison.
Institutional Actions	Monitoring	Groundwater and Surface Water Monitoring	Periodic sampling and analysis to determine whether contamination is migrating and to determine effectiveness of remedial actions.	Retain to assess migration of contaminants and evaluation of remedial actions.
	Access/Use Restrictions	Physical Barriers	Fencing, markers, and warning signs to restrict site access.	Retain to limit exposure to contaminated media.
	Land Use Controls	Groundwater and Land Use Restrictions	Administrative action using site use prohibitions to restrict future activities.	Retain to limit exposure to contaminated media.
Containment	Capping	Soil Cover or Multimedia Cap	Use of soil cover or low-permeability barriers to minimize exposure to contaminants and migration of contaminants.	Retain to minimize exposure to contaminated material and to minimize contaminant migration.
	Erosion Control	Riprap Cover or Vegetation	Use of stone/gravel or dense plant growth to minimize migration of waste.	Retain to minimize disruptive effects of remediation.
	Vertical Barriers	Slurry Wall, Grout Curtain, and Sheet Piling	Low-permeability wall formed in a perimeter trench to restrict horizontal movement of groundwater.	Eliminate. Off-site migration of contaminants from groundwater to surface water is not a concern.
Removal	Excavation	Excavation	Means for removal of waste.	Retain to remove contaminated media.
In-Situ Treatment	Thermal	Vitrification/Radio Frequency Heating	Use of high temperature to fuse inorganic contaminants into a glass matrix or use of moderate temperature to volatilize contaminants and remove them from the vadose zone.	Eliminate because of ineffectiveness and implementability concerns under shallow groundwater conditions. Not proven effective with heterogeneous material (e.g., landfill waste).

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

General Response Action	Technology	Process Option	Description	Screening Comments
In-Situ Treatment (Cont.)	Physical/Chemical	Soil Flushing	Use of water or solvents to remove contaminants from the vadose zone by leaching and collecting contaminated wastewater in the saturated zone followed by aboveground treatment.	Eliminate because of questionable effectiveness with heterogeneous material.
		Soil Vapor Extraction	Use of vacuum and possibly air sparging to remove contaminants from the vadose zone.	Eliminate because volatile organic contaminants in soil are not a risk driver.
		Solidification	Use of pozzolanic materials in the vadose zone to chemically fix inorganics and solidify the matrix to reduce leachability.	Eliminate because of questionable effectiveness and implementability with heterogeneous material.
Ex-Situ Treatment	Physical/Chemical	Soil Washing/ Solvent Extraction	Use of water and solvents to remove contaminants from solid materials.	Eliminate because of questionable effectiveness with heterogeneous material.
		Solidification	Use of pozzolanic materials to chemically fix inorganics and solidify the matrix to reduce leachability.	Eliminate because of questionable effectiveness and implementability with heterogeneous material.
	Biological	Landfarming	Tilling of contaminated soil in layers to remove volatile organic compounds and biodegrade organics.	Eliminate because it is not applicable to landfill material.
		Bioslurry Treatment	Treatment of soil in a slurry reactor under controlled conditions using natural or cultured microorganisms to biodegrade organics.	Eliminate because it is not applicable to landfill material.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

General Response Action	Technology	Process Option	Description	Screening Comments
Ex-Situ Treatment (Cont.)	Thermal	Incineration	Use of high temperature to destroy organic contaminants.	Eliminate because organics are not chemicals of concern.
		Low-Temperature Thermal Desorption	Use of low to moderate temperature to volatilize contaminants.	Eliminate because organics are not chemicals of concern.
Disposal	Landfill	Hazardous or Non-Hazardous Waste Landfill	Disposal of excavated material at a permitted on-site or off-site landfill.	Retain off-site landfilling to permanently remove contaminated materials. Eliminate on-site landfilling because suitable area is not available.
		Consolidation	Excavation and placement in one location on site to minimize space and closure requirements.	Retain for possible combination and use with containment technology.

NCP: National Oil and Hazardous Substances Pollution Contingency Plan

TABLE 3-2

SUMMARY OF RETAINED TECHNOLOGIES AND PROCESS OPTIONS
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

General Response Action	Technology	Representative Process Option
No Action	None	Not Applicable
Institutional Action	Monitoring	Groundwater and Surface Water Monitoring
	Land Use Controls	Shallow Groundwater and Land Use Restrictions
Containment	Capping	Soil Cover
		Multimedia Cap
	Erosion Controls	Riprap Cover or Vegetation
Removal	Excavation	Excavation
Disposal	Landfill	On-Site Consolidation
		Off-Site Landfill

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

4.1 INTRODUCTION

This section presents the rationale for and the development of remedial alternatives evaluated in the FS. These alternatives were developed from the combinations of technologies and process options evaluated in Section 3.0.

4.2 RATIONALE FOR ALTERNATIVE DEVELOPMENT

The purpose of the FS was to evaluate the information developed during the SSP investigations that assess site conditions and to develop an appropriate range of alternatives to allow remedy selection. According to CERCLA, the development of alternatives should reflect the scope and complexity of the site problems being addressed, and the number and types of alternatives should also be based on the site characteristics and the complexity of site concerns. Development of alternatives for Site 36 was based on the following:

- Technologies and process options remaining after screening in Section 3.0
- Reasonably anticipated land use scenarios
- Exposure scenarios
- RAO
- ARARs

4.2.1 Technologies and Process Options

GRAs and representative process options were developed for the landfill at Site 36. The GRAs and process options retained for assembly into alternatives are as follows:

General Response Action	Process Options
No Action	None
Institutional Action	Groundwater and Surface Water Monitoring
	Shallow Groundwater and Land Use Restrictions
Containment	Soil Cover
	Multimedia Cap
	Riprap Erosion Control
	Vegetative Erosion Control

General Response Action	Process Options
Removal	Excavation
Disposal	On-Site Consolidation
	Off-Site Landfill

These process options were used individually or in combination, as appropriate, to form remedial alternatives in Section 4.3.

4.2.2 Land Use Scenarios

Potential exposure to environmental media is evaluated in the context of current land use and future land use. Under current and future land use, Site 36 is not used and would remain as a former waste disposal area. Under future land use, Site 36 could be released to the public (which is not anticipated) or remain under the control of the Navy. While under the control of the Navy, the site is expected to be inactive.

4.2.3 Exposure Scenarios

Assumptions for the land use scenarios and receptors used for alternative development are consistent with the human health and ecological risk screening evaluations contained in the SSP Report (Tetra Tech, 2008).

Under the current land use scenario, Site 36 is assumed to remain as it currently exists. No adverse health effects are expected for current human receptors. There are no unacceptable risks to ecological receptors.

Potential receptors under potential future land use scenarios include on-site residents. Possible adverse health effects would be expected for hypothetical future residents exposed to shallow groundwater and landfill waste. No adverse health effects would be expected for exposure to other environmental media. Potential risks to ecological receptors would not be expected.

4.2.4 Accommodation of RAOs and ARARs

In general, it is desirable to develop remedial alternatives that achieve compliance with all RAOs and ARARs. However, in certain cases, technical limitations and costs prevent the development of alternatives that attain all clean-up goals for all media.

Alternatives have not been assembled for remediation of shallow groundwater to meet ARARs because of the following:

- The shallow water-bearing unit beneath Site 36 would not be classified as an aquifer. Site 36 was previously a wetland or part of Chickamuxen Creek that was filled to create the existing topography. Under its natural setting before being filled, the water would have existed as surface water associated with Chickamuxen Creek or the wetland.

- Shallow groundwater at Site 36 is not currently used as a source of drinking water.

- Shallow groundwater at Site 36 is not expected to be developed as a source of drinking water in the future because it is a landfill.

- Migration of shallow groundwater contaminants is not adversely affecting surface water or sources of potable water.

4.3 REMEDIAL ALTERNATIVE DEVELOPMENT

This section develops the remedial alternatives for Site 36 considering the information provided in Section 4.2. The following alternatives have been developed for the landfill:

- Alternative 1 – No Action
- Alternative 2 – Land Use Controls
- Alternative 3 – Soil Cover with Land Use Controls
- Alternative 4 – Engineered Cap with Land Use Controls
- Alternative 5 – Landfill Removal

4.3.1 Alternative 1 – No Action

Under Alternative 1, no controls or remedial technologies would be implemented.

At least every 5 years, a site review would be conducted to evaluate the monitoring results, to evaluate the site status (i.e., the sites then-current use and plans for future use), to review environmental laws and regulations in effect at the time of the review, and to provide direction for further action, if deemed necessary. Site reviews are required because this alternative would allow the landfill to remain in place with groundwater contaminants remaining at concentrations exceeding those suitable for unlimited use and unrestricted exposure.

The no-action alternative is required by the NCP and is used as a baseline for comparison with other alternatives.

4.3.2 Alternative 2 – Land Use Controls

Alternative 2 includes debris removal, LUCs, monitoring, and 5-year reviews.

Metal debris present along the shoreline would be removed and sold as scrap.

LUCs would consist of maintaining records of the restrictions in the GIS that is maintained by NSF-IH. Unauthorized excavation, residential development, and shallow groundwater use would not be permitted. Maintaining information in the GIS would ensure that the Navy would be able to take adequate measures to minimize the potential for adverse human and environmental effects at the time of any future land development.

Monitoring would include sampling of shallow groundwater beneath Site 36 and surface water and sediment in Chickamuxen Creek and analysis for groundwater COCs (arsenic, iron, and manganese). The objective of monitoring would be to confirm that no contaminants are migrating from the site at unacceptable levels and to confirm the effectiveness of the remedy.

At least every 5 years, a site review would be conducted to evaluate the monitoring results, to evaluate the site status (i.e., the sites then-current use and plans for future use), to review environmental laws and regulations in effect at the time of the review, and to provide direction for further action, if deemed necessary. Site reviews are required because this alternative would allow the landfill to remain in place with groundwater contaminants remaining at concentrations exceeding those suitable for unlimited use and unrestricted exposure.

4.3.3 Alternative 3 – Soil Cover and Land Use Controls

Alternative 3 includes debris removal, a soil cover, LUCs, monitoring, and 5-year reviews.

Metal debris present along the shoreline would be removed and sold as scrap.

The landfill would be cleared of all vegetation, covered with clean soil, and revegetated. The soil cover would consist of 18 inches of clean fill and 6 inches of topsoil.

This alternative would include the same LUCs, monitoring, and 5-year review components as described for Alternative 2.

4.3.4 Alternative 4 – Engineered Cap and Land Use Controls

Alternative 4 includes debris removal, an engineered cap, LUCs, monitoring, and 5-year reviews.

Metal debris present along the shoreline would be removed and sold as scrap.

The landfill would be cleared of all vegetation, filled and graded to an acceptable slope, capped, and revegetated. The engineered cap would consist of several layers including (from the bottom to top) a low-permeability layer, drainage layer, final earthen cover, and vegetative stabilization.

This alternative would include the same LUCs, monitoring, and 5-year review components as described for Alternative 2.

4.3.5 Alternative 5 – Landfill Removal

Alternative 5 includes debris and landfill removal. Metal debris present along the shoreline would be removed and sold as scrap. The landfill materials would be excavated and transported off site for disposal. All of the waste observed in previous soil borings was below the water table (approximately 4 feet bgs). Therefore, some of the excavated material would need to be dewatered prior to disposal. The site would not be backfilled, and the excavated area would become part of Chickamuxen Creek. It may be possible to stockpile some of the soil excavated above the waste for use as partial backfill to allow creation of a wetland.

LUCs, monitoring, and 5-year reviews would not be required because no contamination would remain at the site.

4.4 SCREENING OF ALTERNATIVES

Alternatives can be screened to decrease the number of alternatives that are carried forward for detailed analysis. This step in the FS process is conducted, when appropriate, to eliminate alternatives that do not achieve protection of human health and the environment. Alternatives should be eliminated if they are significantly less effective than more promising alternatives, are not technically or administratively implementable, or have significantly higher costs.

The alternatives developed and described for Site 36 are considered to represent an appropriate range of alternatives. All alternatives are considered effective and implementable. Therefore, all of the alternatives will be carried forward for detailed analysis.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

In this section, each remedial alternative developed in Section 4.0 is described and analyzed in detail. The detailed analysis was conducted in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1998b) and the NCP. The detailed analysis of remedial alternatives provides information for the comparison of alternatives in Section 6.0 and the selection of a preferred alternative in the Proposed Plan. The following criteria were used for the detailed analysis of each alternative:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with ARARs

Primary Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- State acceptance
- Community acceptance

The first two criteria are threshold criteria in that each alternative must meet them. The next five criteria are grouped together because they represent the primary criteria on which the analysis is based. The alternative that best matches the five balancing criteria is proposed to EPA, the state, and the community as the preferred remedy. The final two criteria, state and community acceptance, will be evaluated following comments on the FS and Proposed Plan and will be addressed after a final decision is made and the Record of Decision (ROD) is being prepared. The following is a description of each of the nine evaluation criteria.

Overall Protection of Human Health and the Environment – The primary requirement for CERCLA remedial actions is that they are protective of human health and the environment. A remedy is protective if it adequately eliminates, reduces, or controls all current and potential future risks. All pathways of exposure must be considered when evaluating the remedial alternative. If hazardous substances remain without engineering or land use controls after the remedy is implemented, the evaluation must consider unrestricted land use and unlimited exposure for human and environmental receptors. For those sites where hazardous substances remain and unrestricted use and unlimited access are not allowable, engineering controls, LUCs, or some combination of the two must be implemented to control exposure and ensure reliable protection over time. In addition, implementation of a remedy cannot result in unacceptable short-term risks to or cross-media impacts on human health and the environment.

Compliance with ARARs – Compliance with ARARs is one of the statutory requirements for remedy selection. Alternatives are developed and refined throughout the FS process to ensure that they will meet all their respective ARARs or that there is adequate rationale for waiving an ARAR. Alternatives may be refined to ensure compliance with these requirements.

Long-Term Effectiveness and Permanence – This criterion reflects the CERCLA emphasis on implementing remedies that will ensure protection of human health and environment in the future, as well as in the near term. In evaluating alternatives for long-term effectiveness and the degree of permanence they afford, the analysis focuses on the residual risks that will remain at the site after completion of the remedial action. This analysis also considers the following:

- Degree of threat posed by the hazardous substances remaining at the site.
- Adequacy of any controls (e.g., engineering and land use controls) used to manage the hazardous substances remaining at the site.
- Reliability of those controls.
- Potential impacts on human health and the environment if the remedy should fail, based on assumptions included in the reasonable maximum exposure scenario.

Reduction of Toxicity, Mobility, or Volume Through Treatment – This criterion addresses the statutory preference for remedies that employ treatment as a principal element by ensuring that the relative performance of the various treatment alternatives in reducing toxicity, mobility, or volume will be assessed. The analysis also examines the magnitude, significance, and irreversibility of reductions.

Short-Term Effectiveness – This criterion examines the short-term impacts of the alternatives (i.e., impacts of the implementation) on the neighboring community, workers, and surrounding environment. This includes potential threats to human health and the environment associated with excavation, treatment, and transportation of hazardous substances. The potential cross-media impacts of the remedy and the time to achieve protection of human health and the environment are analyzed.

Implementability – Implementability considerations include the technical and administrative feasibility of the alternative. Implementability also considers the availability of goods and services (e.g., treatment, storage, or disposal capacity) on which the viability of the alternative depends. Implementation considerations often affect the timing of the various alternatives (e.g., limitations on the season in which the remedy can be implemented, the number and complexity of material-handling steps that must be followed, the need to obtain permits for off-site activities, and the need to secure technical services).

Cost – Cost includes all capital and O&M costs incurred over the life of the project. The focus of the detailed analysis is on the net present values of these costs. Costs are used to select the least expensive or most cost-effective alternative that will achieve RAOs. A 30-year maintenance life and a 7-percent annual discount factor are used to calculate the present worth of the capital and O&M costs.

State Acceptance – This criterion, which is an ongoing consideration during the remediation process, reflects the statutory requirement to provide substantial and meaningful state involvement.

Community Acceptance – This criterion refers to community comments on the remedial alternatives under consideration. Community is broadly defined to include all interested parties. These comments are taken into account throughout the FS process; however, only preliminary assessment of community acceptance can be conducted during development of the FS. Formal public comments will not be received until after the public comment period for the preferred alternative is held.

5.2 DESCRIPTION AND ANALYSIS OF ALTERNATIVES

5.2.1 Alternative 1 – No Action

5.2.1.1 Detailed Description

Under Alternative 1, no controls or remedial technologies would be implemented to address landfill waste and shallow groundwater contamination. The no-action alternative is required by the NCP and is used as a baseline for comparison with other alternatives. For this alternative, the site would be available for unrestricted use because no LUCs would be implemented.

Site Review

At least every 5 years, a site review would be conducted to evaluate monitoring results, to evaluate the site status, and to determine whether further action is necessary. These site reviews are required because this alternative would allow contaminants to remain at the site in excess of levels that allow for unlimited use and unrestricted exposure.

5.2.1.2 Overall Protection of Human Health and the Environment

Alternative 1 would not be protective of human health and the environment. Landfill waste and shallow groundwater contamination could pose a potential future threat under the residential exposure scenario.

5.2.1.3 Compliance with ARARs

Alternative 1 would not comply with ARARs, including state landfill closure requirements.

5.2.1.4 Long-Term Effectiveness and Permanence

The future threats to human health and the environment would remain. There would be no long-term management controls; therefore, the adequacy and reliability of controls would not be applicable. There would be no long-term monitoring program to confirm that contaminant migration from the site is not occurring.

5.2.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not include treatment to reduce the toxicity, mobility, or volume of the hazardous substances on site.

5.2.1.6 Short-Term Effectiveness

Alternative 1 would not pose any short-term risks to the local community or on-site workers during implementation because no actions would occur. There would be no environmental risks from implementation.

5.2.1.7 Costs

The estimated costs for Alternative 1 would be as follows:

- Capital: $0
- O&M: $20,000 every 5 years
- Present worth: $42,700

The present-worth cost is based on a 30-year monitoring period. Conceptual design calculations and details of the cost estimates are provided in Appendix A.

5.2.1.8 State Acceptance

The no-action alternative would not be recommended because it does not meet the threshold criteria. Therefore, there would be no opportunity for state review, comments, or acceptance.

5.2.1.9 Community Acceptance

The no-action alternative would not be recommended because it does not meet the threshold criteria. Therefore, there would be no opportunity for community review, comments, or acceptance.

5.2.2 Alternative 2 – Land Use Controls

5.2.2.1 Detailed Description

Under Alternative 2, metal debris present along the shoreline would be removed. LUCs would be implemented to protect human health by ensuring that there is no unauthorized excavation, residential use, or shallow groundwater use. Monitoring would be performed to confirm that contaminants are not migrating off site to Chickamuxen Creek at unacceptable levels.

Debris Removal

Large pieces of metal debris along the shoreline would be removed and disposed off site (e.g., recycled).

Land Use Controls

Land and groundwater use restrictions would be implemented to eliminate or reduce exposure pathways. LUCs would consist of maintaining records of the restrictions in the NSF-IH GIS. The information in the GIS would ensure that the Navy would be able to take adequate measures to minimize adverse human health effects at the time of any future land development. Unauthorized excavation, residential use, and shallow groundwater use would not be permitted. A LUC Remedial Design would need to be prepared to document these restrictions.

Monitoring

Monitoring of shallow groundwater and surface water would be conducted to confirm that groundwater contaminant migration to Chickamuxen Creek is not occurring at unacceptable levels and to evaluate the effectiveness of the remedy. It is assumed that samples would be collected annually from the three existing monitoring wells and four locations within the creek. All samples would be analyzed for arsenic, iron, and manganese (i.e., groundwater COCs). A long-term monitoring plan would need to be developed with EPA and Maryland Department of the Environment (MDE) concurrence.

Site Review

At least every 5 years, a site review would be conducted to evaluate monitoring results, to evaluate the site status, and to determine whether further action is necessary. These site reviews are required because this alternative would allow contaminants to remain at the site in excess of levels that allow for unlimited use and unrestricted exposure.

5.2.2.2 Overall Protection of Human Health and the Environment

Alternative 2 would protect human health by removing metal debris along the shoreline and implementing land and groundwater use restrictions. This would reduce the potential for human exposure to landfill waste through dermal contact and exposure to groundwater within the waste through ingestion and dermal contact. Groundwater and surface water monitoring would help in confirming the effectiveness of this alternative, determining whether contaminants are migrating at unacceptable levels, and evaluating whether future action is required.

5.2.2.3 Compliance with ARARs

There are no chemical-specific ARARs associated with this alternative. Although the maximum arsenic concentration in shallow groundwater (22.4 µg/L) exceeds the EPA Maximum Contaminant Level (MCL) for drinking water (10 µg/L), groundwater beneath the landfill is not within the area of attainment, as defined by EPA. The concentration may decrease over time as a result of natural attenuation processes. There are no location-specific ARARs associated with this alternative. Implementation would not adversely affect local surface water, wetlands, or the Chickamuxen Creek floodplain.

This alternative would not comply with state closure standards for sanitary landfills that require an impermeable cap to be installed (COMAR 26.04.07.21). However, state solid waste management regulations contain provisions for a variance to design requirements if the proposed changes conserve and protect the public health, natural resources, and environment of the state and control air, water, and land pollution to the same extent as would be obtained by compliance with the regulation. The shallow groundwater beneath the site is not considered to be a naturally formed aquifer and is not within the area of attainment defined by EPA. Therefore, an impermeable cap is not needed to protect groundwater. In addition, the existing soil cover appears to be stable and not highly erodible, and of sufficient thickness to prevent direct exposure risks and limit precipitation infiltration through evapotranspiration. Chemicals detected in soil are not migrating to Chickamuxen Creek at unacceptable levels. Therefore, an impermeable cap or soil cover is not needed to protect local surface water. The heavy vegetative cover existing at the site would preclude releases to air.

If MDE grants a variance to COMAR 26.04.07.21, this alternative would comply with state post-closure maintenance and monitoring requirements for sanitary landfills.

5.2.2.4 Long-Term Effectiveness and Permanence

Exposed debris along the shoreline would be permanently removed. The landfill waste and shallow groundwater contaminants would remain at the site. Land and groundwater use restrictions would reduce the potential human health hazards associated with exposure to landfill waste and shallow groundwater under a residential use exposure scenario. Monitoring would help in confirming the effectiveness of this alternative, determining whether contaminants are migrating at unacceptable levels, and evaluating whether future action is required.

Land and groundwater use restrictions would be protective over the long term. A 5-year periodic review of the site would be conducted as long as landfill waste and shallow groundwater contaminants remain at concentrations that exceed those suitable for unlimited use and unrestricted exposure. Any private ownership of the land in the future would need to be controlled by a deed restriction to control land and groundwater use.

5.2.2.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 does not include active treatment to reduce the toxicity, mobility, or volume of the hazardous substances at the site.

5.2.2.6 Short-Term Effectiveness

The remedial activities associated with this alternative would not be expected to have an adverse impact on the community, on-site workers, or the environment.

It is expected that the RAO could be achieved within 1 month because land and groundwater use restrictions can be implemented within this time frame.

5.2.2.7 Implementability

Alternative 2 would be implementable. Equipment and services necessary to remove the debris from the shoreline are readily available. Land and groundwater use restrictions could be strictly enforced because the site is located at a military facility.

5.2.2.8 Cost

The estimated costs for Alternative 2 would be as follows:

- Capital: $91,000
- O&M: $18,000 per year plus $20,000 every 5 years
- Present worth: $358,000

The present-worth cost is based on a 30-year monitoring period. Conceptual design calculations and details of the cost estimates are provided in Appendix A.

5.2.2.9 State Acceptance

State acceptance would be addressed following receipt of comments on the FS and Proposed Plan.

5.2.2.10 Community Acceptance

Community acceptance would be addressed in the ROD following the public comment period on the FS and Proposed Plan.

5.2.3 Alternative 3 – Soil Cover and Land Use Controls

5.2.3.1 Detailed Description

Under Alternative 3, metal debris present along the shoreline would be removed. A soil cover would be installed, and LUCs would be implemented to protect human health by ensuring that there is no unauthorized excavation, residential use, or shallow groundwater use. Monitoring would be performed to confirm that contaminants are not migrating off site at unacceptable levels.

Debris Removal

Large pieces of metal debris along the shoreline would be removed and disposed off site (e.g., recycled).

Soil Cover

Covering the landfill would be a containment action. The purpose of the soil cover would be to eliminate or reduce the possibility of human exposure to potential physical hazards and to reduce erosion. The site would be cleared of all vegetation. An area of approximately 3.4 acres would be covered with a minimum of 18 inches of clean fill and 6 inches of topsoil, graded, and revegetated. The shoreline would be stabilized, if needed, to protect the soil cover. Figure 5-1 shows the area to be covered, and Figure 5-2 shows a conceptual cross-section of the soil cover.

Land Use Controls

Land and groundwater use restrictions would be implemented to eliminate or reduce exposure pathways. LUCs would consist of maintaining records of the restrictions in the NSF-IH GIS. The information in the GIS would ensure that the Navy would be able to take adequate measures to minimize adverse human health effects at the time of any future land development. Unauthorized excavation, residential use, and shallow groundwater use would not be permitted. A LUC Remedial Design would need to be prepared to document these restrictions.

Monitoring

To accommodate placement of the soil cover, existing monitoring wells would be abandoned in accordance with state regulations then reinstalled for use in shallow groundwater monitoring. Monitoring of shallow groundwater and surface water would be conducted to confirm that groundwater contaminant migration to Chickamuxen Creek is not occurring at unacceptable levels and to evaluate the effectiveness of the remedy. It is assumed that samples would be collected annually from three monitoring wells and four locations within the creek. All samples would be analyzed for arsenic, iron, and manganese (i.e., groundwater COCs). A long-term monitoring plan would need to be developed with EPA and MDE concurrence.

Site Review

At least every 5 years, a site review would be conducted to evaluate the monitoring results, to evaluate the site status, and to determine whether further action is necessary. The site reviews are required because this alternative would allow contaminants to remain at the site in excess of levels that allow for unlimited use and unrestricted exposure.

5.2.3.2 Overall Protection of Human Health and the Environment

Alternative 3 would protect human health by removing metal debris along the shoreline, installing a soil cover, and implementing land and groundwater use restrictions. This would reduce the potential for human exposure to landfill waste through dermal contact and exposure to groundwater contaminants through ingestion and dermal contact. Groundwater and surface water monitoring would help in confirming the effectiveness of this alternative, determining whether contaminants are migrating at unacceptable levels, and evaluating whether future action is required.

5.2.3.3 Compliance with ARARs

There are no chemical-specific ARARs associated with this alternative. Although the maximum arsenic concentration in shallow groundwater (22.4 µg/L) exceeds the MCL (10 µg/L), groundwater beneath the landfill is not within the area of attainment as defined by EPA.

Installation of the soil cover could disturb wetlands and require minor work in Chickamuxen Creek. This alternative could be designed to meet location-specific ARARs associated with work in wetlands and surface water. Any wetlands destroyed during installation of the soil cover would need to be replaced.

This alternative would not comply with state closure standards for sanitary landfills that require an impermeable cap to be installed (COMAR 26.04.07.21). However, state solid waste management regulations contain provisions for a variance to design requirements if the proposed changes conserve and protect the pubic health, natural resources, and the environment of the state and control air, water, and land pollution to the same extent as would be obtained by compliance with the regulation. The shallow groundwater beneath the site is not considered to be a naturally formed aquifer and is not within the area of attainment as defined by EPA. Therefore, an impermeable cap is not needed to protect groundwater. Chemicals detected in soil are not migrating to Chickamuxen Creek at unacceptable levels. Therefore, an impermeable cap is not needed to protect local surface water. The soil cover and vegetation would preclude releases to air.

If MDE grants a variance to COMAR 26.04.07.21, this alternative would comply with state post-closure maintenance and monitoring requirements for sanitary landfills.

5.2.3.4 Long-Term Effectiveness and Permanence

Exposed debris along the shoreline would be permanently removed. The landfill waste and groundwater contaminants would remain at the site, and the entire landfill area would be permanently covered. Land and groundwater use restrictions would reduce the potential human health hazards associated with exposure to landfill waste and shallow groundwater under a residential use exposure scenario. Monitoring would help in confirming the effectiveness of this alternative, determining whether contaminants are migrating at unacceptable levels, and evaluating whether future action is required.

Land and groundwater use restrictions would be protective over the long term. A 5-year periodic review of the site would be conducted as long as landfill waste and groundwater contaminants remain at concentrations that exceed those suitable for unlimited use and unrestricted exposure. Any private ownership of the land in the future would need to be controlled under a deed restriction to control land and groundwater use.

5.2.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 would not include treatment to reduce the toxicity, mobility, or volume of the hazardous substances at the site.

5.2.3.6 Short-Term Effectiveness

The remedial activities associated with construction of a soil cover would not be expected to have an adverse impact on the community.

Exposure of workers to contaminated media during soil cover placement and monitoring activities would be minimized by the use of appropriate personal protective equipment (PPE), engineering controls, and compliance with a site-specific health and safety plan (HASP) and Occupational Safety and Health Administration (OSHA) regulations.

Installation of the soil cover would require that all existing vegetation be removed from the site. This would destroy the existing ecological habitat until the vegetation to be planted on the soil cover becomes established.

Installation of the soil cover could have a short-term impact on Chickamuxen Creek and associated wetlands. Erosion controls would be provided during earth-moving activities to prevent migration of soil to the creek. Any wetlands that are adversely affected would be replaced. Any dust that is generated could be adequately controlled.

It is expected that the RAO could be achieved within a 2-month construction duration.

5.2.3.7 Implementability

Alternative 3 would be implementable. Equipment and services necessary to remove debris from the shoreline and construct the soil cover are readily available. Land and groundwater use restrictions could be strictly enforced because the site is located at a military facility.

5.2.3.8 Cost

The estimated costs for Alternative 3 would be as follows:

- Capital: $1,094,000
- O&M: $18,000 per year plus $20,000 every 5 years
- Present worth: $1,361,000

The present worth is based on a 30-year monitoring period. Conceptual design calculations and details of the cost estimates are provided in Appendix A.

5.2.3.9 State Acceptance

State acceptance would be addressed following receipt of comments on the FS and Proposed Plan.

5.2.3.10 Community Acceptance

Community acceptance would be addressed in the ROD following the public comments period on the FS and Proposed Plan.

5.2.4 Alternative 4 – Engineered Cap and Land Use Controls

5.2.4.1 Detailed Description

Under Alternative 4, metal debris present along the shoreline would be removed. An engineered cap would be installed, and LUCs would be implemented to protect human health by ensuring that there is no unauthorized excavation, residential use, or shallow groundwater use. Monitoring would be performed to confirm that contaminants are not migrating off site at unacceptable levels.

Debris Removal

Large pieces of metal debris along the shoreline would be removed and disposed off site (e.g., recycled).

Engineered Cap

Capping the landfill would be a containment action. The purpose of capping would be to eliminate or reduce the possibility of human exposure to potential physical hazards, reduce the rate of surface water infiltration, and reduce erosion. An area of approximately 3.4 acres would be capped (see Figure 5-1). Common clean soil fill would be added and graded to provide sufficient slope to promote drainage from the completed cap and to provide a bedding layer for the cap. Following completion of the subgrade layer, a cap system with the following layers (from bottom to top) would be installed (see Figure 5-3):

- 6-inch gas management layer
- Low-permeability synthetic geomembrane with a minimum thickness of 40 mils and a maximum permeability of 1E-10 centimeters per second
- 12-inch drainage layer
- 18-inch layer of clean common soil fill
- 6-inch layer of clean topsoil
- Vegetative stabilization layer

Land Use Controls

Land and groundwater use restrictions would be implemented to eliminate or reduce exposure pathways. LUCs would consist of maintaining records of the restrictions in the NSF-IH GIS. The information in the GIS would ensure that the Navy would be able to take adequate measures to minimize adverse human health effects at the time of any future land development. Unauthorized excavation, residential use, and shallow groundwater use would not be permitted. A LUC Remedial Design would need to be prepared to document these restrictions.

Monitoring

To accommodate placement of the engineered cap, existing monitoring wells would be abandoned in accordance with state regulations then reinstalled for use in shallow groundwater monitoring. Monitoring of shallow groundwater and surface water would be conducted to confirm that groundwater contaminant migration to Chickamuxen Creek is not occurring at unacceptable levels and to evaluate the effectiveness of the remedy. It is assumed that samples would be collected annually from three monitoring wells and four locations within the creek. All samples would be analyzed for arsenic, iron, and manganese (i.e., groundwater COCs). A long-term monitoring plan would need to be developed with EPA and MDE concurrence.

Site Reviews

At least every 5 years, a site review would be conducted to evaluate the monitoring results, to evaluate the site status, and to determine whether further action is necessary. The site reviews are required because this alternative would allow contaminants to remain at the site in excess of levels that allow for unlimited use and unrestricted exposure.

5.2.4.2 Overall Protection of Human Health and the Environment

Alternative 4 would protect human health by removing metal debris along the shoreline, installing an engineered cap, and implementing land and groundwater use restrictions. This would reduce the potential for human exposure to landfill waste through dermal contact and exposure to groundwater contaminants through ingestion and dermal contact. Groundwater and surface water monitoring would help in confirming the effectiveness of this alternative, determine whether contaminants are migrating at unacceptable levels, and evaluating whether further action is required.

5.2.4.3 Compliance with ARARs

There are no chemical-specific ARARs associated with this alternative. Although the maximum arsenic concentration in shallow groundwater (22.4 µg/L) exceeds the MCL (10 µg/L), groundwater beneath the landfill is not within the area of attainment as defined by EPA.

Installation of the engineered cap may disturb wetlands and require minor work in Chickamuxen Creek. This alternative can be designed to meet location-specific ARARs associated with work in wetlands and surface water. Any wetlands destroyed during installation of the engineered cap would need to be replaced.

This alternative would comply with state closure (i.e., capping) standards and post-closure maintenance and monitoring requirements for sanitary landfills.

5.2.4.4 Long-Term Effectiveness and Permanence

Exposed debris along the shoreline would be permanently removed. The landfill waste and shallow groundwater contaminants would remain at the site, and the entire landfill would be permanently capped. Land and groundwater use restrictions would reduce the potential human health hazards associated with exposure to landfill waste and shallow groundwater under a residential use exposure scenario. Monitoring would help in confirming the effectiveness of this alternative, determining whether contaminants are migrating at unacceptable levels, and evaluating whether future action is required.

Land and groundwater use restrictions would be protective over the long term. A 5-year periodic review of the site would be conducted as long as landfill waste and groundwater contaminants remain at concentrations that exceed those suitable for unlimited use and unrestricted exposure. Any private ownership of the land in the future would need to be controlled under a deed restriction to control land and groundwater use.

5.2.4.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would not include treatment to reduce the toxicity, mobility, or volume of the hazardous substances at the site.

5.2.4.6 Short-Term Effectiveness

The remedial activities associated with construction of an engineered cap would not be expected to have an adverse impact on the community.

Exposure of workers to contaminated media during capping and monitoring activities would be minimized by the use of PPE, engineering controls, and compliance with a site-specific HASP and OSHA regulations.

Installation of the engineered cap would require that all existing vegetation be removed from the site. This would destroy the existing ecological habitat until the vegetation to be planted on the cap had become established. The cap could not be vegetated with brush and trees, which comprise much of the existing vegetation. The cap would need to be vegetated with plants, such as grasses, that would not penetrate the impermeable geosynthetic membrane. This could permanently alter the existing ecological habitat.

Installation of the engineered cap could have a short-term impact on Chickamuxen Creek and associated wetlands. Erosion controls would be provided during earth-moving activities to prevent migration of soil to the creek. Any wetlands adversely affected would be replaced. Any dust that is generated could be adequately controlled.

It is expected that the RAO could be achieved within a 4-month construction duration.

5.2.4.7 Implementability

Alternative 4 would be implementable. Equipment and services needed to remove debris from the shoreline and construct the engineered cap are readily available. Land and groundwater use restrictions could be strictly enforced because the site is located at a military facility.

5.2.4.8 Cost

The estimated costs for Alternative 4 would be as follows:

- Capital: $2,887,000
- O&M: $18,000 per year plus $20,000 every 5 years
- Present worth: $3,154,000

The present worth is based on a 30-year monitoring period. Conceptual design calculations and details of the cost estimates are provided in Appendix A.

5.2.4.9 State Acceptance

State acceptance would be addressed following receipt of comments on the FS and Proposed Plan.

5.2.4.10 Community Acceptance

Community acceptance would be addressed in the ROD following the public comment period on the FS and Proposed Plan.

5.2.5 Alternative 5 – Landfill Removal

5.2.5.1 Detailed Description

Under Alternative 5, the entire landfill and metal debris present along the shoreline would be removed. There would be no need for LUCs, monitoring, or 5-year reviews.

Debris Removal

Large pieces of metal debris along the shoreline would be removed and disposed off site (e.g., recycled).

Landfill Removal

The landfill contents would be excavated and hauled off site for disposal at a permitted non-hazardous waste landfill. All of the waste encountered at the site is below the water table, and it would be difficult to dewater the excavation. Therefore, after excavation proceeds below the water table, the excavated material would need to be dewatered before it could be transported off site. The water would be allowed to drain back into the excavation, and the waste would be allowed to dry naturally until landfill waste acceptance criteria are met. Also, all excavated material would be screened and inspected for munitions and explosives of concern (MEC) before it is transported off site. It is estimated that 56,000 cubic yards of materials would require excavation. The excavation would proceed vertically until waste is no longer encountered based on visual inspection of the material being excavated. Confirmation samples would then be collected from the excavated area.

The site would not be completely backfilled following excavation, and the site would be allowed to revert to surface water or could be converted into a wetland. For cost estimation purposes, this alternative assumes that wetland vegetation would be planted following partial backfilling of the excavated area. Based on available information, surface soil is not contaminated and does not pose potential risks to human health, ecological receptors, or the environment. Some of the subsurface soil that overlies the buried waste also may not be contaminated. It is assumed that some of this soil could be stockpiled and used as backfill material after the waste was removed.

Land Use Controls, Monitoring, and 5-Year Reviews

LUCs, monitoring, and 5-year reviews would not be required because all waste would be removed from the site. Shallow groundwater currently beneath the site would not exist following excavation because the area would revert to surface water or be converted into a wetland.

5.2.5.2 Overall Protection of Human Health and the Environment

Alternative 5 would protect human health by removing all landfill waste from the site. This would eliminate all exposure pathways.

5.2.5.3 Compliance with ARARs

There are no chemical-specific ARARs associated with this alternative.

Excavation would disturb Chickamuxen Creek and may disturb wetlands. This alternative could be designed to meet location-specific ARARs associated with work in surface water and wetlands. Following remediation, the site would become part of Chickamuxen Creek or would be converted into a wetland.

This alternative could be designed to meet action-specific ARARs associated with waste generation and storm water management during construction.

5.2.5.4 Long-Term Effectiveness and Permanence

Landfill waste would be permanently removed from the site. All of the waste is below the water table. Following waste removal, shallow groundwater would no longer be present because the former site area would become part of Chickamuxen Creek or a wetland.

5.2.5.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 5 does not include treatment to reduce the toxicity, mobility, or volume of hazardous substances at the site.

5.2.5.6 Short-Term Effectiveness

Excavation and off-site transport of wastes would have short-term impacts on the community, on-site workers, and the environment. Hauling wastes off site would generate additional traffic. Although there would be a potential for spills during transport, all materials would be solids that could easily be placed back into the transport container. Any dust that would be generated could be adequately controlled.

Exposure of workers to contaminated media during excavation activities would be minimized by the use of PPE, engineering controls, and compliance with a site-specific HASP and OSHA regulations. Because of the past and ongoing mission of NSF-IH, MEC could be encountered during excavation activities. Unexploded ordnance (UXO) technicians would need to inspect areas to be excavated to address potential safety issues. It would be difficult to inspect material that is underwater before being excavated.

Removing the landfill would destroy the existing ecological habitat. The terrestrial habitat would be replaced by open water if the site is to become part of Chickamuxen Creek or wetland if the site is partially backfilled and planted with suitable vegetation. Erosion controls would be provided during earth-moving activities to prevent migration of soil and waste to the creek. Shallow groundwater beneath the landfill would become surface water as excavation proceeds. There could be localized short-term impacts in the creek until concentrations of groundwater COCs are diluted by surface water in the creek.

It is expected that the RAO could be achieved within a construction duration of 16 months.

5.2.5.7 Implementability

Although excavation and off-site disposal are common remediation techniques, Alternative 5 would be difficult to implement. There are implementability concerns associated with excavation of waste below the water table and screening excavated materials for MEC. Based on available data, waste was encountered at depths ranging from 8 to 12 feet bgs, and the water table was encountered at a depth of 4 feet bgs. Another concern would be associated with the effort to dewater the expected volume of excavated material because 60 percent of the material to be excavated is below the water table. It is assumed that excavation would begin near the shoreline and progress inland. As the landfill materials are removed, there would be less area available to construct the dewatering pads.

Alternative 5 might involve rigorous procedures for MEC avoidance, removal, treatment/demilitarization, and disposal. It would be difficult to check for the presence of MEC during excavation below the water table.

5.2.5.8 Cost

The estimated costs for Alternative 5 would be as follows:

- Capital: $18,952,000
- O&M: $0
- Present worth: $18,952,000

The present worth would be the same as the capital costs because there would be no annual O&M costs. Conceptual design calculations and details of the cost estimate are provided in Appendix A.

5.2.5.9 State Acceptance

State acceptance would be addressed following receipt of comments on the FS and Proposed Plan.

5.2.5.10 Community Acceptance

Community acceptance would be addressed in the ROD following the public comments period on the FS and Proposed Plan.

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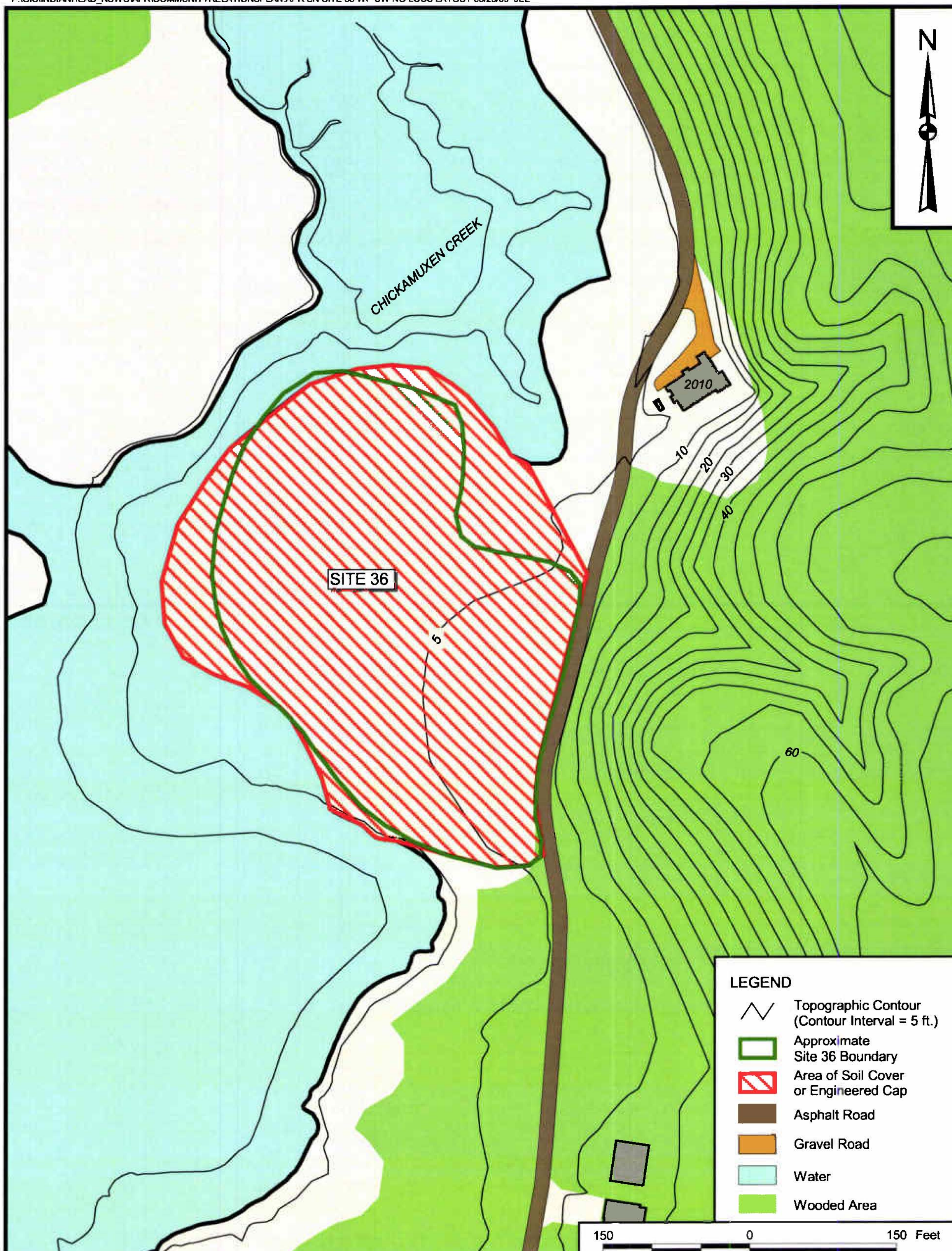
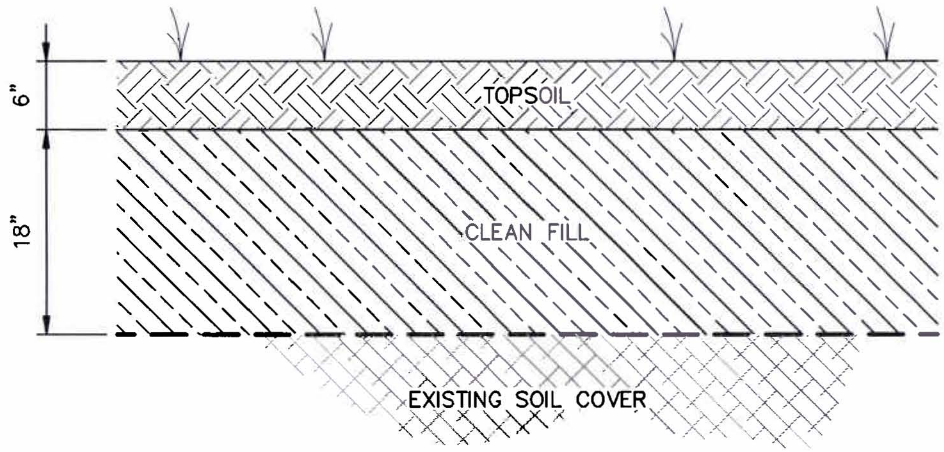


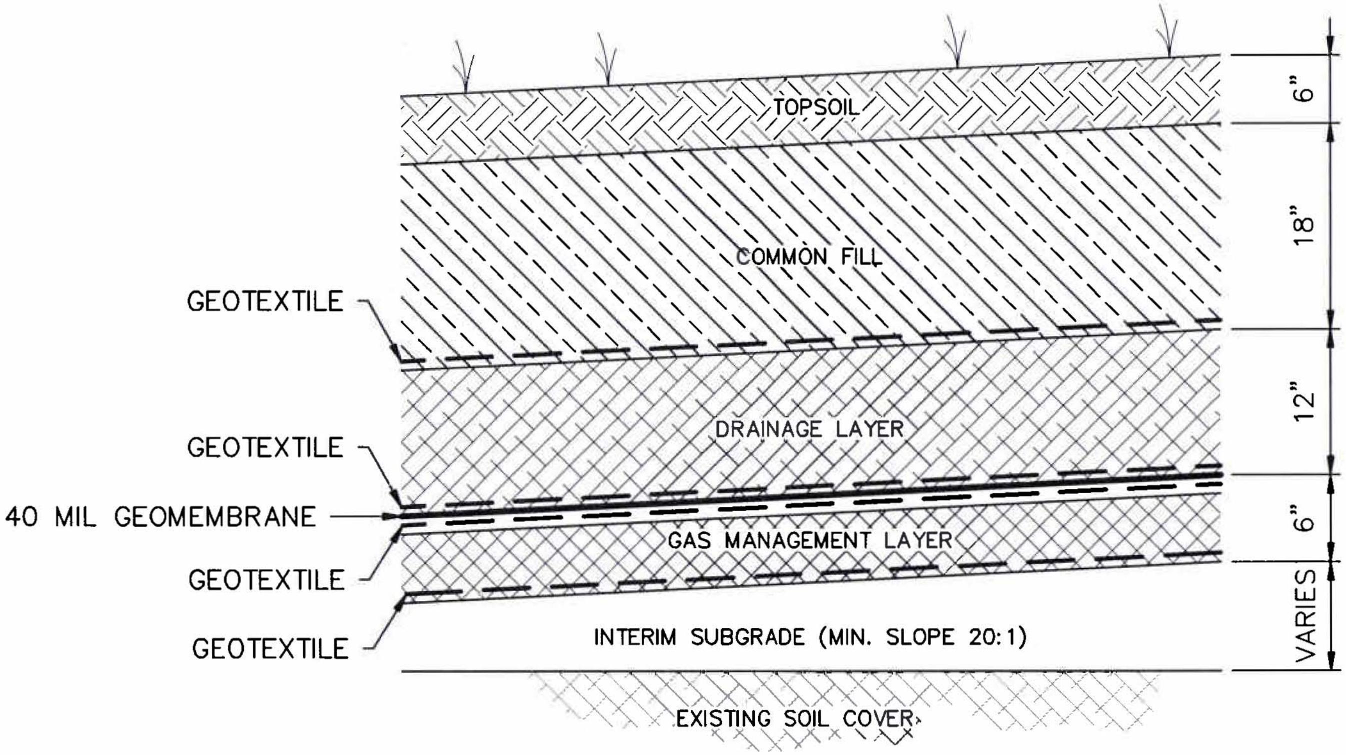
DRAWN BY K MOORE	DATE 11/21/06	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO JU03
CHECKED BY K. TURNBULL	DATE 03/25/09	ALTERNATIVE 3 (SOIL COVER) AND ALTERNATIVE 4 (ENGINEERED CAP) SITE 36 - CLOSED LANDFILL NAVAL SUPPORT FACILITY, INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY KCT — DATE 3/20/09
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-1 — REV 0



TETRA TECH WWW.TETRATECH.COM	ALTERNATIVE 3 – SOIL COVER CROSS–SECTION SITE 36 – CLOSED LANDFILL NAVAL SUPPORT FACILITY, INDIAN HEAD INDIAN HEAD, MARYLAND
661 ANDERSEN DRIVE – FOSTER PLAZA 7 PITTSBURGH, PA 15220 T: (412) 921–7090 | F: (412) 921–4040	SCALE: NOT TO SCALE

DATE:	3–24–09
PROJECT NO.:	112G01867
DESIGNED BY:	KT
DRAWN BY:	BH
CHECKED BY:	KT
SHEET: 1 OF 2	

FIGURE 5–2



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ALTERNATIVE 4 – ENGINEERED CAP
CROSS-SECTION
SITE 36 – CLOSED LANDFILL
NAVAL SUPPORT FACILITY, INDIAN HEAD
INDIAN HEAD, MARYLAND

SCALE: NOT TO SCALE

DATE:	3-24-09
PROJECT NO.:	112G01867
DESIGNED BY:	KT
DRAWN BY:	BH
CHECKED BY:	KT
SHEET: 2 OF 2	

FIGURE 5-3

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the alternatives were evaluated in relation to one another with respect to each of the evaluation criteria. The purpose of this analysis was to identify the relative advantages and disadvantages of each alternative.

Table 6-1 summarizes the comparative analysis of alternatives for Site 36.

6.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All the alternatives, except Alternative 1 (No Action), would provide adequate protection of human health.

Alternative 5 (Landfill Removal) would protect human health and the environment to the greatest extent by removing all landfill waste. Shallow groundwater beneath the site would no longer exist and the former landfill area would be allowed to revert to open surface water or be converted into a wetland.

Alternatives 2 (LUCs), 3 (Soil Cover), and 4 (Engineered Cap) would protect human health to a lesser extent through implementation of LUCs to restrict land and groundwater use. Alternatives 3 and 4 provide additional cover material that would further minimize direct contact with buried waste materials. Alternative 2 relies on the existing cover material to minimize direct contact.

Alternatives 2, 3, and 4 would include shallow groundwater and surface water monitoring to protect the environment. Monitoring would provide evidence that contaminants are not migrating to Chickamuxen Creek at unacceptable levels and to facilitate a decision to cease monitoring. The engineered cap under Alternative 4 would reduce infiltration and the potential for migration of contaminants to shallow groundwater.

Shallow groundwater contaminants would be allowed to naturally attenuate under Alternatives 2, 3, and 4; however, shallow groundwater beneath the landfill is not within the area of attainment, as defined by EPA. This means that remediation of shallow groundwater would not be an RAO as long as contaminants are not migrating to Chickamuxen Creek.

6.2 COMPLIANCE WITH ARARS

There are no chemical-specific ARARs associated with any of the alternatives. Although the maximum arsenic concentration in shallow groundwater (22.4 µg/L) exceeds the MCL (10 µg/L), groundwater beneath the landfill is not within the area of attainment as defined by EPA. There is no shallow groundwater downgradient of the landfill because the site is adjacent to Chickamuxen Creek.

Alternatives 2, 3, 4, and 5 would comply with all location-specific ARARs associated with work in wetlands and surface water. Any wetlands that are destroyed during implementation of these alternatives would need to be replaced.

Alternatives 4 and 5 would comply with action-specific ARARs, including state sanitary landfill closure requirements. Alternative 4 would also comply with post-closure maintenance and monitoring requirements.

If MDE grants a variance to COMAR 26.04.07.21, Alternatives 2 and 3 would comply with state post-closure maintenance and monitoring requirements for sanitary landfills. State solid waste management regulations contain provisions for a variance from design requirements if the proposed changes conserve and protect the public health, natural resources, and environment of the state and control air, water, and land pollution to the same extent as would be obtained by compliance with the regulations. Shallow groundwater beneath the site is not considered to be a naturally formed aquifer and is not within the area of attainment as defined by EPA. Therefore, an impermeable cap is not needed to protect groundwater. Chemicals detected in soil are not migrating to Chickamuxen Creek at unacceptable levels. Therefore, an impermeable cap or soil cover is not needed to protect local surface water. These alternatives would comply with state landfill post-closure maintenance and monitoring requirements.

If MDE grants a variance to COMAR 26.04.07.21, Alternative 1 would comply with state post-closure maintenance and monitoring requirements for sanitary landfills.

6.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 5 would be the most protective over the long term because the landfill waste would be removed from the site. LUCs and long-term monitoring would not be required.

Alternatives 2, 3, and 4 would be less effective in the long term because the landfill waste would remain on site, and LUCs would be needed to restrict land and groundwater use. However, the long-term effectiveness of these alternatives would be monitored, and corrective measures could be taken if necessary. The engineered cap included under Alternative 4 would reduce infiltration and contaminant migration more efficiently than the soil cover under Alternative 3; however, infiltration and off-site contaminant migration are not posing unacceptable risks to human health or the environment.

Monitoring included under Alternatives 2, 3, and 4 would effectively help in confirming the effectiveness of these alternatives, determining whether contaminants are migrating off site at unacceptable levels, and evaluating whether future action is required.

Alternative 1 would not be effective in the long term. The future threats to human health and the environment would remain, and there would be no long-term management or monitoring of the site.

6.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

None of the alternatives include treatment to reduce the toxicity, mobility, or volume of hazardous substances at the site.

6.5 SHORT-TERM EFFECTIVENESS

There would be no short-term effectiveness concerns for Alternative 1 because no action would be implemented.

There would be no adverse impact on the community from implementation of Alternatives 2, 3, and 4. For Alternative 5, hauling wastes off site would generate additional traffic. Although there would be a potential for spills during transport, all materials would be solids that could easily be placed back into the transport container.

There would be no adverse impacts to on-site workers from implementation of Alternative 2. Exposure of remediation workers to contaminated materials under Alternatives 3, 4, and 5 would be controlled by the use of appropriate PPE, engineering controls, and compliance with a site-specific HASP and OSHA regulations.

There would be no adverse impacts to the environment from implementation of Alternative 2. Implementation of Alternatives 3, 4, and 5 would require that all existing vegetation be removed from the site. For Alternatives 3 and 4, this would destroy the existing ecological habitat until the vegetation planted on the soil cover or engineering cap becomes established. For Alternative 4, the cap could not be planted with brush and trees, which comprise much of the existing vegetation. The cap would need to be vegetated with plants such as grasses that would not penetrate the impermeable layer. Following implementation of Alternative 5, the existing terrestrial habitat would revert to open water in Chickamuxen Creek or would be converted to a wetland.

Implementation of Alternatives 3, 4, and 5 could have short-term impacts on Chickamuxen Creek and associated wetlands. Erosion controls would be provided during earth-moving activities to prevent migration of soil to the creek. Any wetlands that are adversely affected during implementation would be replaced. Any dust that is generated could be adequately controlled.

Alternative 1 would not attain the RAO. The RAO could be achieved within the following time frames for the other alternatives:

- Alternative 2: 1 month
- Alternative 3: 2 months
- Alternative 4: 4 months
- Alternative 5 16 months

6.6 IMPLEMENTABILITY

No remedial actions would be implemented under Alternative 1.

Alternatives 2, 3, and 4 are readily implementable. Equipment and services necessary to remove debris from the shoreline, construct a soil cover, and construct an engineered cap are readily available. Land and groundwater use restrictions could be strictly enforced because the site is located at a military facility.

Alternative 5 would be difficult to implement. There are implementability concerns associated with excavation of waste below the water table and dewatering excavated materials. As the landfill is removed, there would be less area available to construct dewatering pads. This alternative might involve rigorous procedures for MEC avoidance, removal, treatment/demilitarization, and disposal. It would be difficult to check for the presence of MEC during excavation below the water table.

6.7 COST

The 30-year present-worth costs of the alternatives would be as follows:

- Alternative 1: $42,700
- Alternative 2: $358,000
- Alternative 3: $1,361,000
- Alternative 4: $3,154,000
- Alternative 5: $18,952,000

6.8 STATE ACCEPTANCE

State acceptance of Alternative 2, 3, 4, or 5 would be addressed following receipt of comments on the FS and Proposed Plan. Alternative 1 would not be recommended because it does not meet the threshold criteria.

6.9 COMMUNITY ACCEPTANCE

Community acceptance of Alternative 2, 3, 4, or 5 would be addressed in the ROD following the public comment period on the FS and Proposed Plan. Alternative 1 would not be recommended because it does not meet the threshold criteria.

TABLE 6-1

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 36 – CLOSED LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

Evaluation Criterion	Alternative 1 – No Action	Alternative 2 – Land Use Controls	Alternative 3 – Soil Cover and Land Use Controls	Alternative 4 – Engineered Cap and Land Use Controls	Alternative 5 – Landfill Removal
Threshold Criteria					
Overall Protection of Human Health and the Environment	No reduction in potential risks.	LUCs would reduce risks to human health and the environment.	Soil cover and LUCs would reduce risks to human health and the environment.	Engineered cap and LUCs would reduce risks to human health and the environment.	Landfill removal would reduce risks to human health and the environment.
Compliance with ARARs					
Chemical-specific	Not applicable.	No ARARs.	No ARARs.	No ARARs.	No ARARs.
Location-specific	Not applicable.	No ARARs.	Could be designed to attain ARARs that apply.	Could be designed to attain ARARs that apply.	Could be designed to attain ARARs that apply.
Action-specific	Not applicable.	Could be designed to attain ARARs that apply. Would qualify for variance from state landfill closure requirements.	Could be designed to attain ARARs that apply. Would qualify for variance from state landfill closure requirements.	Could be designed to attain ARARs that apply. Variance from state landfill closure requirements would not be needed.	Could be designed to attain ARARs that apply. Variance from state landfill closure requirements would not be needed.
Primary Balancing Criteria					
Long-Term Effectiveness and Permanence	Would allow uncontrolled risks to remain.	LUCs would reduce risks to human health. Monitoring and use restrictions would provide adequate and reliable controls.	Soil cover and LUCs would reduce risks to human health. Monitoring and use restrictions would provide adequate and reliable controls.	Engineered cap and LUCs would reduce risks to human health. Monitoring and use restrictions would provide adequate and reliable controls.	Landfill removal would eliminate risks to human health. Monitoring and use restrictions would not be required.
Reduction of Toxicity, Mobility, or Volume through Treatment	No treatment.	No treatment.	No treatment.	No treatment.	No treatment.
Short-Term Effectiveness	Not applicable. No short-term impacts or concerns.	No impacts to community, workers, or environment. One month to implement.	No impacts to community. Exposure of workers to contaminated media could be adequately controlled. Existing habitat would be destroyed until soil cover is revegetated. Two months to implement.	No impacts to community. Exposure of workers to contaminated media could be adequately controlled. Existing habitat would be destroyed until cap is revegetated; could not be planted with existing types of vegetation that could damage impermeable layer. Four months to implement.	Hauling wastes off site would generate additional traffic. Exposure of workers to contaminated media could be adequately controlled. Existing terrestrial habitat would be destroyed and would revert to open water or converted to wetland. Sixteen months to implement.
Implementability	Nothing to implement.	LUCs could be strictly enforced because site is located at military facility.	Alternative consists of common remediation methods that are readily available and implementable. LUCs could be strictly enforced because site is located at military facility.	Alternative consists of common remediation methods that are readily available and implementable. LUCs could be strictly enforced because site is located at military facility.	Alternative consists of common remediation methods that are readily available but would be difficult to implement. There are implementability concerns associated with excavation of waste below the water table and screening excavated materials for MEC.
Cost					
Capital	$0	$91,000	$1,094,000	$2,887,000	$18,952,000
O&M	$0	$18,000 per year plus $20,000 every 5 years	$18,000 per year plus $20,000 every 5 years	$18,000 per year plus $20,000 every 5 years	$0
Present Worth	$0	$358,000	$1,361,000	$3,154,000	$18,952,000
Modifying Criteria					
State Acceptance	Not applicable.	To be determined.	To be determined.	To be determined.	To be determined
Community Acceptance	Not applicable.	To be determined.	To be determined.	To be determined.	To be determined.

ARARs Applicable or relevant and appropriate requirements.
LUCs Land use controls.
MEC Munitions and explosives of concern.
O&M Operation and maintenance.

REFERENCES

EPA (United States Environmental Protection Agency), 1988a. Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites. EPA/540/G-88-003, OSWER Directive 9283.1-2, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1988b. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1995. Land Use in the CERCLA Remedy Selection Process. EPA/540/G-89-004, OSWER Directive 9355.3.01, Office of Emergency and Remedial Response, Washington, D.C.

Hart (Fred C. Hart Associates), 1983. Initial Assessment Study, Naval Ordnance Station, Indian Head, Maryland. Prepared for Navy Assessment and Control of Installation Pollutants (NACIP) Department, Naval Energy and Environmental Support Activity (NEESA), Port Hueneme, California. New York, New York.

Tetra Tech (Tetra Tech NUS, Inc.), 2003. Site Screening Process Report for Site 32 – Suspected Tool Burial Area, Site 33 – Scrap Metal Pit, Site 34 – Tool Burial, Site 36 – Closed Landfill, Site 37 – Causeway, Site 51 – Building 101 Dry Well, and Site 52 – Building 102 Dry Well, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, Washington Navy Yard, D.C. King of Prussia, Pennsylvania.

Tetra Tech, 2008. Site Screening Process Report, Site 36 – Closed Landfill, Naval Support Facility, Indian Head, Maryland. Prepared for Naval Facilities Engineering Command Washington, Washington Navy Yard, D.C. King of Prussia, Pennsylvania.

APPENDIX A

CONCEPTUAL DESIGN CALCULATIONS AND COST ESTIMATES

CLIENT: NAVAL SUPPORT FACILITY, INDIAN HEAD		JOB NUMBER: 112G02050.0000.1110
SUBJECT: Site 36 - Closed Landfill		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 3-24-09	CHECKED BY: KCT Date: 3-24-09	APPROVED BY: DATE:

Landfill Area

Planimeter Figure 4-1 area approximately 6.681 inches square (in sq)
figure scale 1" = 150 ft therefore 1 in sq = 22,500 square feet (sf)

22,500	sf per in sq
6.68	in sq
150,300	sf

Perimeter of landfill along the water
Length from Figure 4-1 = 6 inches
figure scale 1" = 150' therefore 6" = 900 lf

Alternative 2: LUCs and Monitoring

Capital Cost

Debris Removal
Clear limited area for access
Remove debris & disposal offsite: assume 40 tons

Annual Cost

LUC Inspection/Report: Annually
Assume out of town travel to site for two days/two people.

Air	$1,400	
Car	$200	
Per Diem	$516	
Hours	$3,900	(60 hours * $65/hr)
Misc	$250	
	$6,266	

Monitoring Sampling (once a year)
Labor & Materials, per round (3 wells, 4 sediment, & 4 surface water samples)
Assume 4 days to sample with 2 people, local

2 people @ $60.00 per hour for 10 hours per for 4 days =	$4,800
car for 4 days =	$400
report @ $55.00 per hour for 60 hours =	$3,300
Misc supplies, copying, etc. =	$250
	$8,750

Analytical, per round for 30 years
Collect 11 samples and analyze for iron, manganese, arsenic

type	cost each	number	total
iron	$25	11	$275
manganese	$25	11	$275
arsenic	$25	11	$275
			$825
40% QA/QC & Data Validation			$330
			$1,155

CLIENT: NAVAL SUPPORT FACILITY, INDIAN HEAD		JOB NUMBER: 112G02050.0000.1110
SUBJECT: Site 36 - Closed Landfill		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 3-24-09	CHECKED BY: KCT Date: 3-24-09	APPROVED BY: DATE:

Waste Disposal from Sampling

Assume one drum at $250

Five Year Review Cost

Assume $18,000

Alternative 3: Soil Cover

Capital Cost

Site Preparation

Clear & grub area, chip stumps, spread under cap: 150,325 sf
Remove debris & disposal offsite: assume 40 tons
Install turbidity curtain: 900 lf
Regrade landfill
Proof-roll landfill

Landfill Cover

Place material: assume 2 feet of cover (18" fill & 6" topsoil)

Common Fill	150,300	sf
	1.5	ft
	225,450	cf or
	8,350	cy
Topsoil, 6" thick	150,300	sf
	0.5	ft
	75,150	cf or
	2,783	cy
Seed, area + 15%	173	msf
Shoreline Protection	900	ft
	1.5	ft
	150	sy

Time to Complete

	days	
Mobilization	10	
Site prep	10	
Earthwork	20	
Demob	5	
	45	days
	2	months

Annual Cost

Same as Alternative 1

CLIENT: NAVAL SUPPORT FACILITY, INDIAN HEAD		JOB NUMBER: 112G02050.0000.1110
SUBJECT: Site 36 - Closed Landfill		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 3-24-09	CHECKED BY: KCT Date: 3-24-09	APPROVED BY: DATE:

Alternative 4: Landfill Cap

Capital Cost

Site Preparation

Clear & grub area, chip stumps, spread under cap: 150,325 sf
Remove debris & disposal offsite: assume 40 tons
Install turbidity curtain: 900 lf
Proof-roll landfill

Landfill Cap

Place material for interim grade: assume 2.5 feet of fill is need to achieve cap slope (20:1)

	150,300	sf
	2.5	ft
	375,750	cf or
	13,917	cy
Geotextile, 8 oz.	150,300	sf
Gas management layer (6" thick) is the top of the interim grade:		
	150,300	sf
	0.5	ft
	75,150	cf or
GML Volume	2,783	cy
Interim Fill Volume	11,133	cy
Geotextile, 12 oz.	150,300	sf
Liner, 40 mil	150,300	sf
Geotextile, 12 oz.	150,300	sf
Drainage Layer, 12" thick	150,300	sf
	1	ft
	150,300	cf or
	5,567	cy
Common Fill, 18" thick	150,300	sf
	1.5	ft
	225,450	cf or
	8,350	cy
Topsoil, 6" thick	150,300	sf
	0.5	ft
	75,150	cf or
	2,783	cy

CLIENT: NAVAL SUPPORT FACILITY, INDIAN HEAD		JOB NUMBER: 112G02050.0000.1110
SUBJECT: Site 36 - Closed Landfill		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 3-24-09	CHECKED BY: KCT Date: 3-24-09	APPROVED BY: DATE:

Seed, area + 15%	173	msf
Shoreline Protection	900	ft
	1.5	ft
	150	sy

<u>Time to Complete</u>

	days	
Mobilization	10	
Site prep	10	
Earthwork	45	
Liner/Geotextile Placement	20	
Demob	5	
	90	days
	4	months

Annual Cost

Same as Alternative 1

Alternative 5: Landfill Removal

Capital Cost

<u>Assumptions</u>

UXO Technician posted at excavation area and at dewatering/screening area.
Excavation and disposal rate of 192 cubic yards per day.
Water collected during excavation and dewatering activities to be returned to excavation after filtering.
Backfill excavated area with 7,000 cubic yards of soil.
Provide wetlands over 2 acres of excavated area.

<u>Site Preparation</u>

Clear area of trees & bushes, use chipped material for temporary roads.
Remove debris & disposal offsite: assume 40 tons
Install turbidity curtain: 900 lf

<u>Excavations & Disposal</u>

Excavate material and stockpile at excavations face to drain if wet.
Load onto trucks and haul to dewatering/screening pad.
Spread for visual screening and drying.
Once dry, mechanically screen material.
Dispose of material offsite in subtitle D landfill as non-hazardous.
All explosive materials to be removed by the Navy at no cost to the contractor.

CLIENT: NAVAL SUPPORT FACILITY, INDIAN HEAD		JOB NUMBER: 112G02050.0000.1110	
SUBJECT: Site 36 - Closed Landfill			
BASED ON:		DRAWING NUMBER:	
BY: TJR Date: 3-24-09	CHECKED BY: KCT Date: 3-24-09	APPROVED BY:	DATE:

Volume of material to be excavated:	150,300	sf
	10	ft deep
	1,503,000	cf or
	55,667	cy
haul & dispose at 192 cy per day	290	days
disposal at 1.5 tons per cy	83,500	tons

Site Restoration

Backfill area with 7,000 cy of soil
Provide wetlands over 2 acres
Seed area 100 msf

Time to Complete	days	
Mobilization	10	
Site prep	15	
Excavation/Dewatering/Disposal	290	
Site Restoration	15	
Demob	5	
	335	days
	16	months

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 1: No Action
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Site Review		$18,000	Five-Year Site Reviews
SUBTOTAL	$0	$18,000	
Contingency @ 10%	$0	$1,800	
TOTAL	**$0**	**$19,800**	

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 1: LUCs and Monitoring
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0			$0	1.000	$0
1			$0	0.935	$0
2			$0	0.873	$0
3			$0	0.816	$0
4			$0	0.763	$0
5		$19,800	$19,800	0.713	$14,117
6			$0	0.666	$0
7			$0	0.623	$0
8			$0	0.582	$0
9			$0	0.544	$0
10		$19,800	$19,800	0.508	$10,058
11			$0	0.475	$0
12			$0	0.444	$0
13			$0	0.415	$0
14			$0	0.388	$0
15		$19,800	$19,800	0.362	$7,168
16			$0	0.339	$0
17			$0	0.317	$0
18			$0	0.296	$0
19			$0	0.277	$0
20		$19,800	$19,800	0.258	$5,108
21			$0	0.242	$0
22			$0	0.226	$0
23			$0	0.211	$0
24			$0	0.197	$0
25		$19,800	$19,800	0.184	$3,643
26			$0	0.172	$0
27			$0	0.161	$0
28			$0	0.150	$0
29			$0	0.141	$0
30		$19,800	$19,800	0.131	$2,594
				TOTAL PRESENT WORTH	**$42,689**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 2: LUCs and Monitoring
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC Documents	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
1.2 Prepare Documents & Plans including Permits	50	hr			$37.00		$0	$0	$1,850	$0	$1,850
1.3 Prepare Monitoring Plan	120	hr			$37.00		$0	$0	$4,440	$0	$4,440
1.4 Completion Report	20	hr			$37.00		$0	$0	$740	$0	$740
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Equipment Mobilization/Demobilization	2	ea			$170.00	$522.00	$0	$0	$340	$1,044	$1,384
3 FIELD SUPPORT											
3.1 Site Superintendent	5	day		$129.00	$384.64		$0	$645	$1,923	$0	$2,568
3.2 Site Health & Safety and QA/QC	5	day		$129.00	$307.68		$0	$645	$1,538	$0	$2,183
4 DEBRIS REMOVAL											
4.1 Excavator	5	day			$330.80	$1,619.00	$0	$0	$1,654	$8,095	$9,749
4.2 Site Labor, (3 laborers)	5	day			$690.00		$0	$0	$3,450	$0	$3,450
4.3 Debris Removal & Disposal	40	ton	$56.00				$2,240	$0	$0	$0	$2,240
Subtotal							$2,240	$1,290	$21,486	$9,139	$34,155
Overhead on Labor Cost @ 30%									$6,446		$6,446
G & A on Labor Cost @ 10%									$2,149		$2,149
G & A on Material Cost @ 10%								$129			$129
G & A on Equipment Cost @ 10%										$914	$914
G & A on Subcontract Cost @ 10%							$224				$224
Tax on Materials and Equipment Cost @ 6%								$77		$548	$626
Total Direct Cost							$2,464	$1,496	$30,080	$10,601	$44,641
Indirects on Total Direct Cost @ 30%											$13,392
Profit on Total Direct Cost @ 10%											$4,464
Subtotal											$62,498
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$62,498
Contingency on Total Field Costs @ 25%											$15,625
Engineering on Total Field Cost @ 20%											$12,500
TOTAL CAPITAL COST											**$90,622**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 2: LUCs and Monitoring
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Site Inspection	$6,266		Labor and supplies to visit site once a year to inspect Land Use Controls with Report
Monitoring Sampling	$8,750		Labor and supplies to collect 11 samples from 3 wells and 4 sediment/surface water samples, annually years 1-30.
Monitoring Sampling Analysis/Water	$1,155		Analyze groundwater samples for iron, manganese and arsenic including QA/QC cost.
IDW Disposal	$250		Disposal of IDW waste from sampling
Site Review		$18,000	Five-Year Site Reviews
SUBTOTAL	$16,421	$18,000	
Contingency @ 10%	$1,642	$1,800	
TOTAL	**$18,063**	**$19,800**	

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 2: LUCs and Monitoring
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$90,622		$90,622	1.000	$90,622
1		$18,063	$18,063	0.935	$16,889
2		$18,063	$18,063	0.873	$15,769
3		$18,063	$18,063	0.816	$14,739
4		$18,063	$18,063	0.763	$13,782
5		$37,863	$37,863	0.713	$26,996
6		$18,063	$18,063	0.666	$12,030
7		$18,063	$18,063	0.623	$11,253
8		$18,063	$18,063	0.582	$10,513
9		$18,063	$18,063	0.544	$9,826
10		$37,863	$37,863	0.508	$19,234
11		$18,063	$18,063	0.475	$8,580
12		$18,063	$18,063	0.444	$8,020
13		$18,063	$18,063	0.415	$7,496
14		$18,063	$18,063	0.388	$7,008
15		$37,863	$37,863	0.362	$13,706
16		$18,063	$18,063	0.339	$6,123
17		$18,063	$18,063	0.317	$5,726
18		$18,063	$18,063	0.296	$5,347
19		$18,063	$18,063	0.277	$5,003
20		$37,863	$37,863	0.258	$9,769
21		$18,063	$18,063	0.242	$4,371
22		$18,063	$18,063	0.226	$4,082
23		$18,063	$18,063	0.211	$3,811
24		$18,063	$18,063	0.197	$3,558
25		$37,863	$37,863	0.184	$6,967
26		$18,063	$18,063	0.172	$3,107
27		$18,063	$18,063	0.161	$2,908
28		$18,063	$18,063	0.150	$2,709
29		$18,063	$18,063	0.141	$2,547
30		$37,863	$37,863	0.131	$4,960
				TOTAL PRESENT WORTH	**$357,456**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 3: Soil Cover
Capital Cost

			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC Documents	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
1.2 Prepare Documents & Plans including Permits	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
1.3 Prepare Monitoring Plan	120	hr			$37.00		$0	$0	$4,440	$0	$4,440
1.4 Completion Report	80	hr			$37.00		$0	$0	$2,960	$0	$2,960
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Preconstruction Meeting	24	hr			$60.00		$0	$0	$1,440	$0	$1,440
2.2 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.3 Equipment Mobilization/Demobilization	6	ea			$170.00	$522.00	$0	$0	$1,020	$3,132	$4,152
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3.5 Construction Layout Survey	3	day	$1,675.00				$5,025	$0	$0	$0	$5,025
3.6 *Site Superintendent*	45	day		$129.00	$384.64		$0	$5,805	$17,309	$0	$23,114
3.7 Site Health & Safety and QA/QC	45	day		$129.00	$307.68		$0	$5,805	$13,846	$0	$19,651
4 DECONTAMINATION											
4.1 Decontamination Services	2	mo		$1,220.00	$2,245.00	$1,550.00	$0	$2,440	$4,490	$3,100	$10,030
4.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$300.00	$0	$1,500	$2,000	$300	$3,800
4.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
4.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$781.00	$0	$0	$0	$1,562	$1,562
4.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$706.00	$0	$0	$0	$1,412	$1,412
4.6 Disposal of Decon Waste (liquid & solid)	2	mo	$950.00				$1,900	$0	$0	$0	$1,900
5 SITE PREPARATION											
5.1 Underground Utility Clearance	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
5.2 Tree Chipper	3	day				$588.40	$0	$0	$0	$1,765	$1,765
5.3 Stump Chipper	5	day				$201.10	$0	$0	$0	$1,006	$1,006
5.4 Dozer, 200 hp	10	day			$330.80	$1,082.00	$0	$0	$3,308	$10,820	$14,128
5.5 Smooth Drum Roller	10	day			$330.80	$594.60	$0	$0	$3,308	$5,946	$9,254
5.6 Turbidity Curtain	900	lf		$30.00			$0	$27,000	$0	$0	$27,000
5.7 Site Labor, (3 laborers)	10	day			$690.00		$0	$0	$6,900	$0	$6,900
5.8 UXO Technician	10	day			$313.36		$0	$0	$3,134	$0	$3,134
5.9 Debris Removal & Disposal	40	ton	$56.00				$2,240	$0	$0	$0	$2,240
6 SOIL COVER											
6.1 Common Fill	8,350	cy		$12.50			$0	$104,375	$0	$0	$104,375
6.2 Topsoil, 6" thick	2,783	cy		$28.90			$0	$80,429	$0	$0	$80,429
6.3 Seed Cover	173	msf	$75.50				$13,062	$0	$0	$0	$13,062
6.4 Shoreline Protection	150	sy		$19.25	$36.00	$14.90	$0	$2,888	$5,400	$2,235	$10,523
6.5 UXO Technician	20	day			$313.36		$0	$0	$6,267	$0	$6,267
6.6 Dozer, 200 hp	20	day			$330.80	$1,082.00	$0	$0	$6,616	$21,640	$28,256
6.7 Smooth Drum Roller	20	day			$330.80	$594.60	$0	$0	$6,616	$11,892	$18,508
6.8 Sheepsfoot Roller	20	day			$330.80	$1,453.00	$0	$0	$6,616	$29,060	$35,676
6.9 Site Labor, (3 laborers)	20	day			$690.00		$0	$0	$13,800	$0	$13,800
Subtotal							$30,977	$232,581	$122,419	$98,318	$484,295

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 3: Soil Cover
Capital Cost

			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
Overhead on Labor Cost @ 30%									$36,726		$36,726
G & A on Labor Cost @ 10%									$12,242		$12,242
G & A on Material Cost @ 10%								$23,258			$23,258
G & A on Equipment Cost @ 10%										$9,832	$9,832
G & A on Subcontract Cost @ 10%							$3,098				$3,098
Tax on Materials and Equipment Cost @ 6%								$13,955		$5,899	$19,854
Total Direct Cost							$34,074	$269,794	$171,387	$114,049	$589,304
Indirects on Total Direct Cost @ 30%											$176,791
Profit on Total Direct Cost @ 10%											$58,930
Subtotal											$825,025
Health & Safety Monitoring @ 2%											$16,501
Total Field Cost											$841,526
Contingency on Total Field Costs @ 20%											$168,305
Engineering on Total Field Cost @ 10%											$84,153
TOTAL CAPITAL COST											**$1,093,983**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 3: Soil Cover
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Site Inspection	$6,266		Labor and supplies to visit site once a year to inspect Land Use Controls with Report
Monitoring Sampling	$8,750		Labor and supplies to collect 11 samples from 3 wells and 4 sediment/surface water samples, annually years 1-30.
Monitoring Sampling Analysis/Water	$1,155		Analyze groundwater samples for iron, manganese and arsenic including QA/QC cost.
IDW Disposal	$250		Disposal of IDW waste from sampling
Site Review		$18,000	Five-Year Site Reviews
SUBTOTAL	$16,421	$18,000	
Contingency @ 10%	$1,642	$1,800	
TOTAL	**$18,063**	**$19,800**	

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 3: Soil Cover
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,093,983		$1,093,983	1.000	$1,093,983
1		$18,063	$18,063	0.935	$16,889
2		$18,063	$18,063	0.873	$15,769
3		$18,063	$18,063	0.816	$14,739
4		$18,063	$18,063	0.763	$13,782
5		$37,863	$37,863	0.713	$26,996
6		$18,063	$18,063	0.666	$12,030
7		$18,063	$18,063	0.623	$11,253
8		$18,063	$18,063	0.582	$10,513
9		$18,063	$18,063	0.544	$9,826
10		$37,863	$37,863	0.508	$19,234
11		$18,063	$18,063	0.475	$8,580
12		$18,063	$18,063	0.444	$8,020
13		$18,063	$18,063	0.415	$7,496
14		$18,063	$18,063	0.388	$7,008
15		$37,863	$37,863	0.362	$13,706
16		$18,063	$18,063	0.339	$6,123
17		$18,063	$18,063	0.317	$5,726
18		$18,063	$18,063	0.296	$5,347
19		$18,063	$18,063	0.277	$5,003
20		$37,863	$37,863	0.258	$9,769
21		$18,063	$18,063	0.242	$4,371
22		$18,063	$18,063	0.226	$4,082
23		$18,063	$18,063	0.211	$3,811
24		$18,063	$18,063	0.197	$3,558
25		$37,863	$37,863	0.184	$6,967
26		$18,063	$18,063	0.172	$3,107
27		$18,063	$18,063	0.161	$2,908
28		$18,063	$18,063	0.150	$2,709
29		$18,063	$18,063	0.141	$2,547
30		$37,863	$37,863	0.131	$4,960

TOTAL PRESENT WORTH **$1,360,817**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 4: Landfill Cap
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC Documents	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
1.2 Prepare Documents & Plans including Permits	300	hr			$37.00		$0	$0	$11,100	$0	$11,100
1.3 Prepare Monitoring Plan	120	hr			$37.00		$0	$0	$4,440	$0	$4,440
1.4 Completion Report	80	hr			$37.00		$0	$0	$2,960	$0	$2,960
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Preconstruction Meeting	24	hr			$60.00		$0	$0	$1,440	$0	$1,440
2.2 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.3 Equipment Mobilization/Demobilization	6	ea			$170.00	$522.00	$0	$0	$1,020	$3,132	$4,152
3 FIELD SUPPORT											
3.1 Office Trailer	4	mo				$375.00	$0	$0	$0	$1,500	$1,500
3.2 Field Office Equipment, Utilities, & Support	4	mo		$470.00			$0	$1,880	$0	$0	$1,880
3.3 Storage Trailer	4	mo				$99.00	$0	$0	$0	$396	$396
3.4 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3.5 Construction Layout Survey	10	day	$1,675.00				$16,750	$0	$0	$0	$16,750
3.6 Site Superintendent	90	day		$129.00	$384.64		$0	$11,610	$34,618	$0	$46,228
3.7 Site Health & Safety and QA/QC	90	day		$129.00	$307.68		$0	$11,610	$27,691	$0	$39,301
4 DECONTAMINATION											
4.1 Decontamination Services	2	mo		$1,220.00	$2,245.00	$1,550.00	$0	$2,440	$4,490	$3,100	$10,030
4.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$300.00	$0	$1,500	$2,000	$300	$3,800
4.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
4.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$781.00	$0	$0	$0	$1,562	$1,562
4.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$706.00	$0	$0	$0	$1,412	$1,412
4.6 Disposal of Decon Waste (liquid & solid)	2	mo	$950.00				$1,900	$0	$0	$0	$1,900
5 SITE PREPARATION											
5.1 Underground Utility Clearance	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
5.2 Tree Chipper	3	day				$588.40	$0	$0	$0	$1,765	$1,765
5.3 Stump Chipper	5	day				$201.10	$0	$0	$0	$1,006	$1,006
5.4 Dozer, 200 hp	10	day			$330.80	$1,082.00	$0	$0	$3,308	$10,820	$14,128
5.5 Smooth Drum Roller	10	day			$330.80	$594.60	$0	$0	$3,308	$5,946	$9,254
5.6 Turbidity Curtain	900	lf		$30.00			$0	$27,000	$0	$0	$27,000
5.7 Site Labor, (3 laborers)	10	day			$690.00		$0	$0	$6,900	$0	$6,900
5.8 UXO Technician	10	day			$313.36		$0	$0	$3,134	$0	$3,134
5.9 Debris Removal & Disposal	40	ton	$56.00				$2,240	$0	$0	$0	$2,240
6 LANDFILL CAP											
6.1 Interim Fill	11,133	cy		$12.50			$0	$139,163	$0	$0	$139,163
6.2 Geotextile, 8 oz.	150,300	sf		$0.07	$0.16		$0	$10,521	$24,048	$0	$34,569
6.3 Gas Management Layer, 6" thick	2,783	cy		$30.87			$0	$85,911	$0	$0	$85,911
6.4 Gas Vents	1	ls		$5,800.00			$0	$5,800	$0	$0	$5,800
6.5 Geotextile, 12 oz.	150,300	sf		$0.10	$0.16		$0	$15,030	$24,048	$0	$39,078
6.6 Liner, 40 mil	150,300	sf		$0.24	$0.29		$0	$36,072	$43,587	$0	$79,659
6.7 Geotextile, 12 oz.	150,300	sf		$0.10	$0.16		$0	$15,030	$24,048	$0	$39,078
6.8 Drainage Layer, 12" thick	5,567	cy		$32.30			$0	$179,814	$0	$0	$179,814
6.9 Geotextile, 8 oz.	150,300	sf		$0.07	$0.16		$0	$10,521	$24,048	$0	$34,569
6.10 Common Fill, 18" thick	8,350	cy		$12.50			$0	$104,375	$0	$0	$104,375
6.11 Topsoil, 6" thick	2,783	cy		$28.90			$0	$80,429	$0	$0	$80,429
6.12 Seed Cap	173	msf	$75.50				$13,062	$0	$0	$0	$13,062
6.13 Shoreline Protection	150	sy		$19.25	$36.00	$14.90	$0	$2,888	$5,400	$2,235	$10,523
6.14 UXO Technician	25	day			$313.36		$0	$0	$7,834	$0	$7,834
6.15 Dozer, 200 hp	45	day			$330.80	$1,082.00	$0	$0	$14,886	$48,690	$63,576
6.16 Smooth Drum Roller	45	day			$330.80	$594.60	$0	$0	$14,886	$26,757	$41,643
6.17 Sheepsfoot Roller	45	day			$330.80	$1,453.00	$0	$0	$14,886	$65,385	$80,271
6.18 Site Labor, (3 laborers)	45	day			$690.00		$0	$0	$31,050	$0	$31,050

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 4: Landfill Cap
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Subtotal							$42,702	$742,993	$340,679	$177,506	$1,303,880
Overhead on Labor Cost @ 30%									$102,204		$102,204
G & A on Labor Cost @ 10%									$34,068		$34,068
G & A on Material Cost @ 10%								$74,299			$74,299
G & A on Equipment Cost @ 10%										$17,751	$17,751
G & A on Subcontract Cost @ 10%							$4,270				$4,270
Tax on Materials and Equipment Cost @ 6%								$44,580		$10,650	$55,230
Total Direct Cost							$46,972	$861,872	$476,951	$205,907	$1,591,701
Indirects on Total Direct Cost @ 30%											$477,510
Profit on Total Direct Cost @ 10%											$159,170
Subtotal											$2,228,382
Health & Safety Monitoring @ 2%											$44,568
Total Field Cost											$2,272,949
Contingency on Total Field Costs @ 20%											$454,590
Engineering on Total Field Cost @ 7%											$159,106
TOTAL CAPITAL COST											**$2,886,646**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 4: Landfill Cap
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Site Inspection	$6,266		Labor and supplies to visit site once a year to inspect Land Use Controls with Report
Monitoring Sampling	$8,750		Labor and supplies to collect 11 samples from 3 wells and 4 sediment/surface water samples, annually years 1-30.
Monitoring Sampling Analysis/Water	$1,155		Analyze groundwater samples for iron, manganese and arsenic including QA/QC cost.
IDW Disposal	$250		Disposal of IDW waste from sampling
Site Review		$18,000	Five-Year Site Reviews
SUBTOTAL	$16,421	$18,000	
Contingency @ 10%	$1,642	$1,800	
TOTAL	**$18,063**	**$19,800**	

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 4: Landfill Cap
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,886,646		$2,886,646	1.000	$2,886,646
1		$18,063	$18,063	0.935	$16,889
2		$18,063	$18,063	0.873	$15,769
3		$18,063	$18,063	0.816	$14,739
4		$18,063	$18,063	0.763	$13,782
5		$37,863	$37,863	0.713	$26,996
6		$18,063	$18,063	0.666	$12,030
7		$18,063	$18,063	0.623	$11,253
8		$18,063	$18,063	0.582	$10,513
9		$18,063	$18,063	0.544	$9,826
10		$37,863	$37,863	0.508	$19,234
11		$18,063	$18,063	0.475	$8,580
12		$18,063	$18,063	0.444	$8,020
13		$18,063	$18,063	0.415	$7,496
14		$18,063	$18,063	0.388	$7,008
15		$37,863	$37,863	0.362	$13,706
16		$18,063	$18,063	0.339	$6,123
17		$18,063	$18,063	0.317	$5,726
18		$18,063	$18,063	0.296	$5,347
19		$18,063	$18,063	0.277	$5,003
20		$37,863	$37,863	0.258	$9,769
21		$18,063	$18,063	0.242	$4,371
22		$18,063	$18,063	0.226	$4,082
23		$18,063	$18,063	0.211	$3,811
24		$18,063	$18,063	0.197	$3,558
25		$37,863	$37,863	0.184	$6,967
26		$18,063	$18,063	0.172	$3,107
27		$18,063	$18,063	0.161	$2,908
28		$18,063	$18,063	0.150	$2,709
29		$18,063	$18,063	0.141	$2,547
30		$37,863	$37,863	0.131	$4,960
				TOTAL PRESENT WORTH	**$3,153,480**

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 5: Landfill Removal
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans including Permits	300	hr			$37.00		$0	$0	$11,100	$0	$11,100
1.2 Completion Report	100	hr			$37.00		$0	$0	$3,700	$0	$3,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Preconstruction Meeting	24	hr			$60.00		$0	$0	$1,440	$0	$1,440
2.2 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.3 Equipment Mobilization/Demobilization	6	ea			$170.00	$522.00	$0	$0	$1,020	$3,132	$4,152
3 FIELD SUPPORT											
3.1 Office Trailer	16	mo				$375.00	$0	$0	$0	$6,000	$6,000
3.2 Field Office Equipment, Utilities, & Support	16	mo		$470.00			$0	$7,520	$0	$0	$7,520
3.3 Storage Trailer	16	mo				$99.00	$0	$0	$0	$1,584	$1,584
3.4 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3.5 Construction Layout Survey	10	day	$1,675.00				$16,750	$0	$0	$0	$16,750
3.6 Site Superintendent	335	day		$129.00	$384.64		$0	$43,215	$128,854	$0	$172,069
3.7 Site Health & Safety and QA/QC	335	day		$129.00	$307.68		$0	$43,215	$103,073	$0	$146,288
4 DECONTAMINATION											
4.1 Decontamination Services	15	mo		$1,220.00	$2,245.00	$1,550.00	$0	$18,300	$33,675	$23,250	$75,225
4.2 Equipment Decon Pad	1	ls		$7,000.00	$6,500.00	$1,200.00	$0	$7,000	$6,500	$1,200	$14,700
4.3 Decon Water	15,000	gal		$0.20			$0	$3,000	$0	$0	$3,000
4.4 Decon Water Storage Tank, 6,000 gallon	15	mo				$781.00	$0	$0	$0	$11,715	$11,715
4.5 Clean Water Storage Tank, 4,000 gallon	15	mo				$706.00	$0	$0	$0	$10,590	$10,590
4.6 Disposal of Decon Waste (liquid & solid)	15	mo	$950.00				$14,250	$0	$0	$0	$14,250
5 SITE PREPARATION											
5.1 Underground Utility Clearance	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
5.2 Tree Chipper	3	day				$588.40	$0	$0	$0	$1,765	$1,765
5.3 Excavator	15	day			$330.80	$1,619.00	$0	$0	$4,962	$24,285	$29,247
5.4 Turbidity Curtain	900	lf		$30.00			$0	$27,000	$0	$0	$27,000
5.5 Site Labor, (3 laborers)	15	day			$690.00		$0	$0	$10,350	$0	$10,350
5.6 UXO Technician	15	day			$313.36		$0	$0	$4,700	$0	$4,700
5.7 Debris Removal & Disposal	40	ton	$56.00				$2,240	$0	$0	$0	$2,240
6 EXCAVATION AND DISPOSAL											
6.1 Excavator (2)	580	day			$330.80	$1,619.00	$0	$0	$191,864	$939,020	$1,130,884
6.2 Dump Trucks (2)	580	day			$255.40	$1,280.00	$0	$0	$148,132	$742,400	$890,532
6.3 Loader (2)	580	day			$330.80	$854.40	$0	$0	$191,864	$495,552	$687,416
6.4 Dozer, 200 hp	290	day			$330.80	$1,082.00	$0	$0	$95,932	$313,780	$409,712
6.5 Screening Plant	290	day			$312.40	$571.20	$0	$0	$90,596	$165,648	$256,244
6.6 Site Labor, (3 laborers)	290	day			$690.00		$0	$0	$200,100	$0	$200,100
6.7 UXO Technician (2)	590	day			$313.36		$0	$0	$184,882	$0	$184,882
6.8 Transportation and Disposal, subtitle D	83,500	ton	$70.00				$5,845,000	$0	$0	$0	$5,845,000
7 SITE RESTORATION											
7.1 Common Fill	3,500	cy		$12.50			$0	$43,750	$0	$0	$43,750
7.2 Topsoil	3,500	cy		$28.90			$0	$101,150	$0	$0	$101,150
7.3 Wetland Planting	2	ac	$30,000.00				$60,000	$0	$0	$0	$60,000
7.4 Seed Area	173	msf	$75.50				$13,062	$0	$0	$0	$13,062
7.5 Excavator	15	day			$330.80	$1,619.00	$0	$0	$4,962	$24,285	$29,247
7.6 Dozer, 200 hp	15	day			$330.80	$1,082.00	$0	$0	$4,962	$16,230	$21,192
7.7 Site Labor, (3 laborers)	15	day			$690.00		$0	$0	$10,350	$0	$10,350

NAVAL SUPPORT FACILITY - INDIAN HEAD
Indian Head, Maryland
Site 36 - Closed Landfill
Alternative 5: Landfill Removal
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Subtotal							$5,960,052	$295,150	$1,433,019	$2,783,936	$10,472,157
Overhead on Labor Cost @ 30%									$429,906		$429,906
G & A on Labor Cost @ 10%									$143,302		$143,302
G & A on Material Cost @ 10%								$29,515			$29,515
G & A on Equipment Cost @ 10%										$278,394	$278,394
G & A on Subcontract Cost @ 10%							$596,005				$596,005
Tax on Materials and Equipment Cost @ 6%								$17,709		$167,036	$184,745
Total Direct Cost							$6,556,057	$342,374	$2,006,227	$3,229,366	$12,134,023
Indirects on Total Direct Cost @ 30%	(excluding transportation and disposal cost)										$1,882,432
Profit on Total Direct Cost @ 10%											$1,213,402
Subtotal											$15,229,858
Health & Safety Monitoring @ 2%											$304,597
Total Field Cost											$15,534,455
Contingency on Total Field Costs @ 20%											$3,106,891
Engineering on Total Field Cost @ 2%											$310,689
TOTAL CAPITAL COST											**$18,952,035**